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ABSTRACT

Plate Tectonics Cycle is one of the units of a K-6 unified science curriculum program. The unit consists of four organizing sub-themes: (1) volcanoes (covering formation, distribution, and major volcanic groups); (2) earthquakes (with investigations on wave movements, seismograms and sub-suface earth currents); (3) plate tectonics (providing maps and models of continental movement); and (4) hazards (identifying the damage associated with volcanoes and earthquakes and the techniques and scales for assessing them). Each sub-theme contains an introductory statement, student activities for lower primary grades (K-3) and upper primary grades (4-6) and a teacher's copy for each student worksheet. Student worksheets are ready for duplicating. (ML)

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PLATE TECTONIC CYCLE
EARTHQUAKES

Understanding why we have earthquakes can teach students about the inside of the earth, the movement of the outside of the earth, energy and waves. The concepts are difficult to understand if not presented in a logical fashion.

LOWER PRIMARY

A. Description of earthquakes - Does the earth open up? How long does an earthquake last? Is there more than one earthquake at a time?

B. Development of Wave Movements - What is a wave? What creates waves? Can waves change shape? Is an ocean wave and an earthquake (seismic) wave the same? Why do ducks bob up and down in the water? Can waves go through the earth?

UPPER PRIMARY

Since students have an understanding of the energy in the form of waves that is released during an earthquake, they can now develop the following concepts:

C. Measuring an earthquake - What are the different types of scales that record earthquakes? What is an epicenter? How do you find an epicenter?

D. Wave movements and seismograms - Can you record a wave? Do all waves look alike? How many waves are there? What is a seismogram?

E. Dividing the earth by waves - Do the waves inside the earth change their speed? What does changing waves tell us about the internal structure of the earth?

K - 6 Science Curriculum

Joint Project by Math Science Nucleus
and U.S. Geological Survey

SE 046 345

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name

earth

quake

shake

What happens during an earthquake?

TEACHER SHEET

IDEA HERE TO EMPHASIZE TO THE CHILDREN THAT THE WHOLE EARTH SHAKES, NOT JUST ONE LITTLE AREA. POINT OUT THAT THE EARTHQUAKE IS EASIEST FELT AT THE PLACE WHERE IT STARTED. THE FARTHER YOU GET FROM THE QUAKE THE LESS YOU FEEL IT.

name

earth

quake

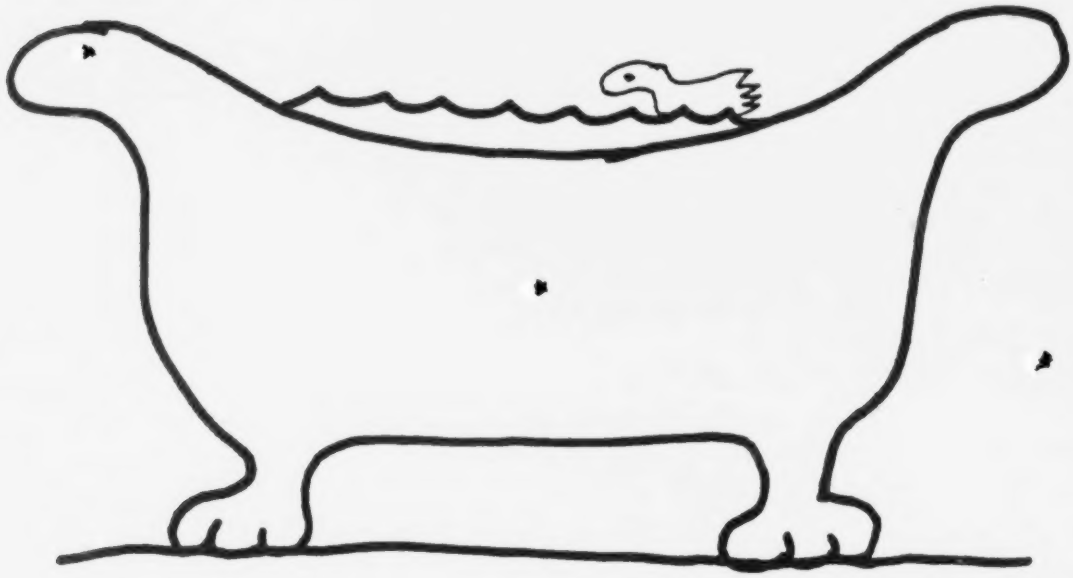
shake

What happens during an earthquake?

name _____

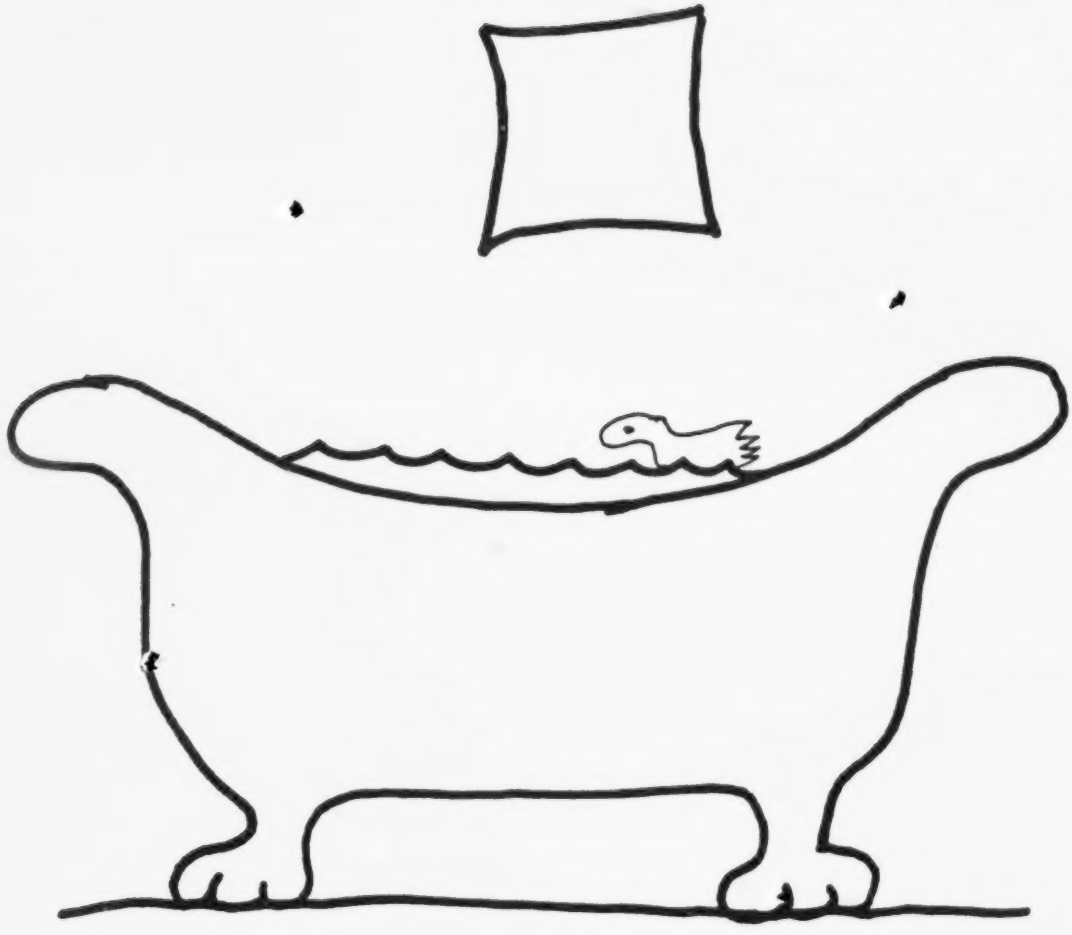
TEACHER SHEET

IF THE STUDENT IS A BODY OF ENERGY, THE ENERGY THAT HE OR SHE EMITS WHEN HE/SHE JUMPS IN, CREATES WAVES. WAVES ARE THEN AN EXPRESSION OF ENERGY. THE LARGER THE PERSON JUMPING IN THE LARGER THE WAVE. EMPHASIZE THAT THE RUBBER DUCKY WILL BOB UP AND DOWN BECAUSE OF THE ENERGY. THIS EXERCISE GETS STUDENTS TO THINKS ABOUT THE CONNECTION BETWEEN WAVES AND ENERGY. EARTHQUAKES EMIT ENERGY THAT MOVES ALONG BY WAVES.



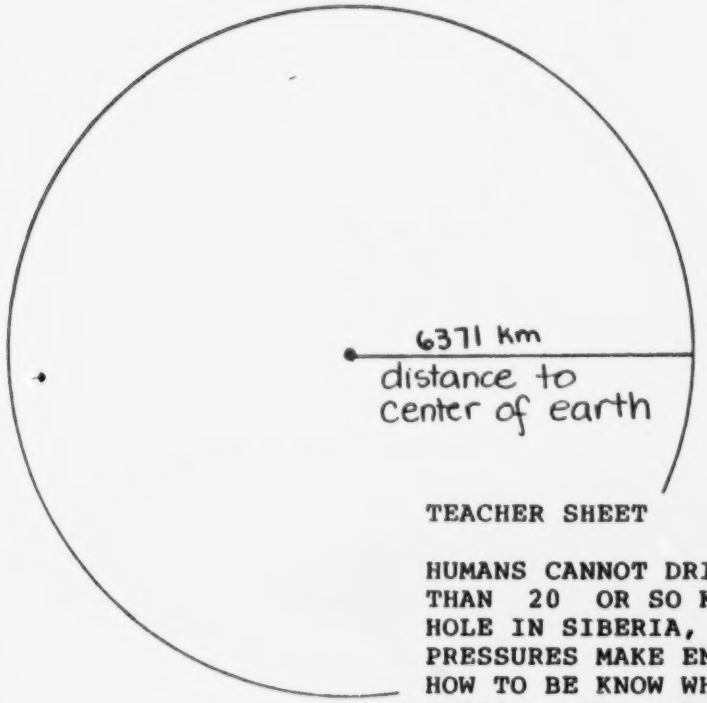
Jump into the bathtub. Draw what happens.

name _____



Jump into the bathtub. Draw what happens.

the earth



name

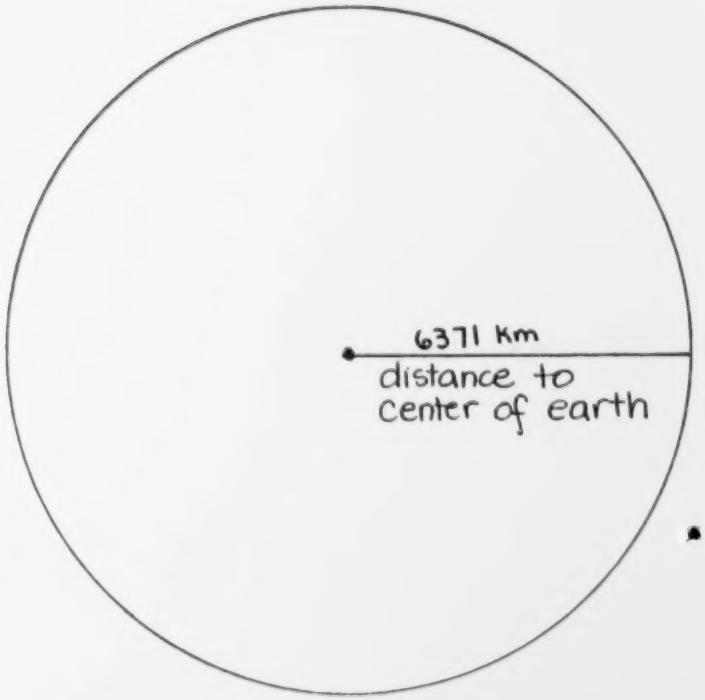
How far can we drill into the earth? Why?

TEACHER SHEET

HUMANS CANNOT DRILL DEEP INTO THE EARTH. WE CAN NOT DRILL MORE THAN 20 OR SO KILOMETERS. RUSSIA IS NOW DRILLING THE DEEPEST HOLE IN SIBERIA, BUT IT IS DIFFICULT. EXTREME TEMPERATURES AND PRESSURES MAKE ENTRY INTO THE EARTH HARD. ASK THE STUDENTS...THEN HOW TO BE KNOW WHAT IS INSIDE THE EARTH? EXPLANATION - DIFFERENT TYPES OF ROCKS WILL TRANSMIT WAVES AT DIFFERENT SPEEDS...RECORDING THESE WAVES WILL GIVE US CLUES.

Place a X at the depth you think we can drill to

the earth



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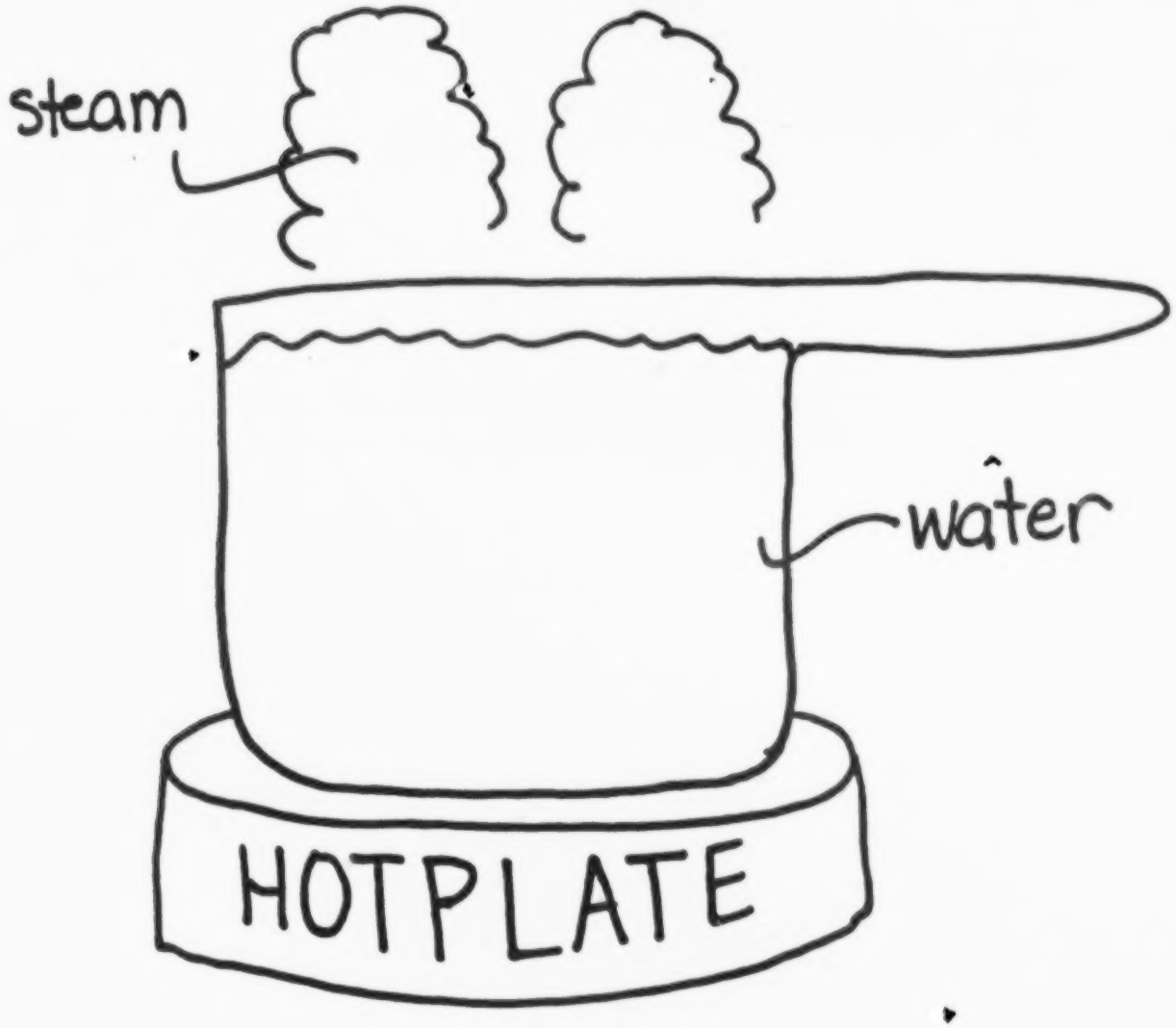
name

How far can we drill into the earth? Why?

name _____

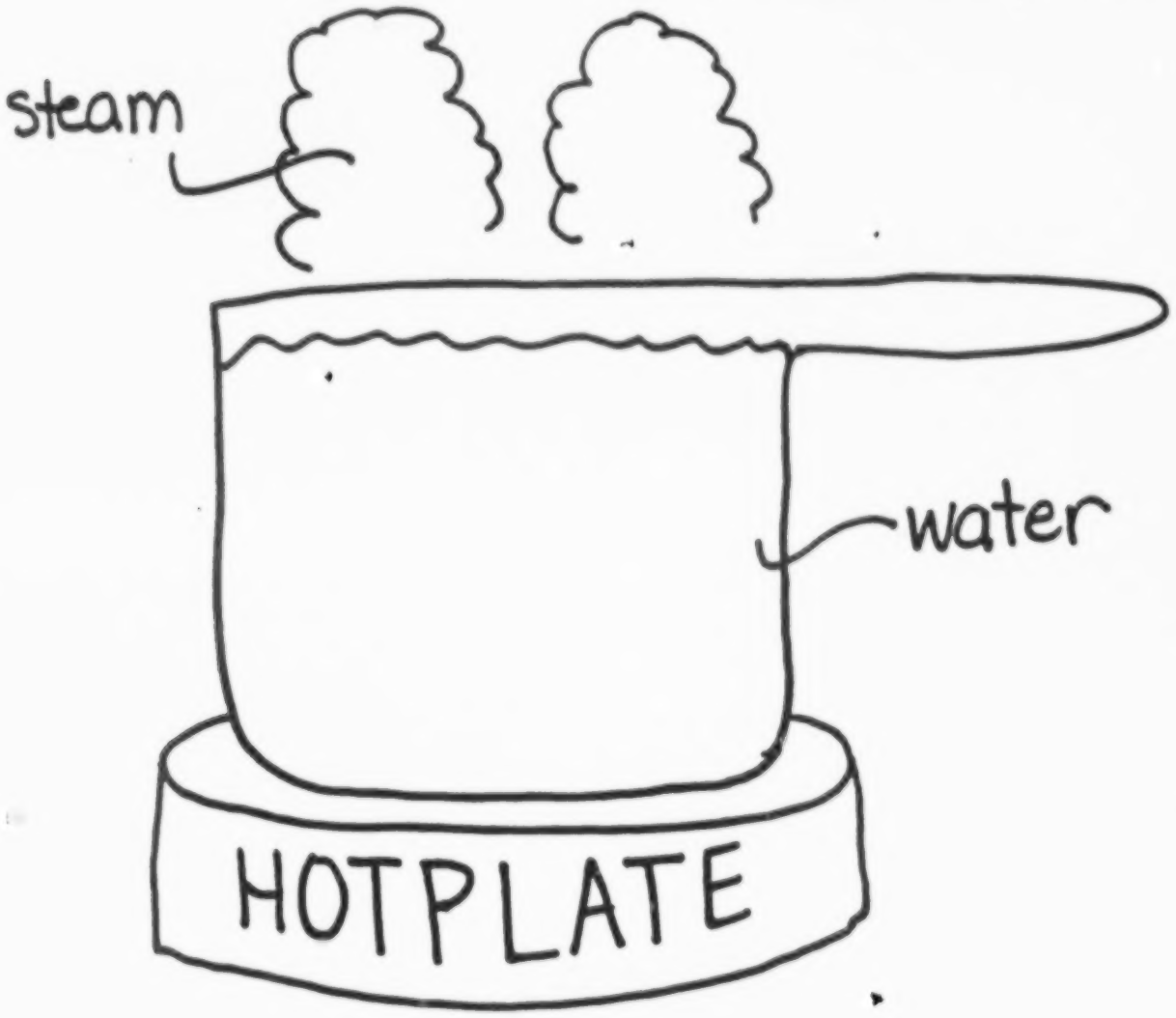


How does water boil? Trace the movement of water molecules in the pot of water above. You have just explained a convection current.

TEACHER SHEET

- STUDENTS HAVE TO LEARN WHY THE EARTH IS SO RESTLESS. THEY MUST UNDERSTAND CERTAIN PRINCIPLES FIRST. CONVECTION CURRENTS INSIDE THE EARTH HELP EXPLAIN THE MOVEMENT OF THE CRUST OF THE EARTH.
- THIS EXERCISE GETS THE IDEA OF CONVECTION CURRENTS CAUSED BY HEATING AND COOLING. YOU CAN GET A GLASS POT OVER A HOT PLATE
- TO DEMOSTRATE THIS PRINCIPLE.

name _____



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name _____

There is a friendly monster inside the earth. Geos wants to get out, but he doesn't want to hurt any living creature on earth. How can he get out without hurting anyone? Geos can change to any shape that he wants. He can become liquid also.

TEACHER SHEET

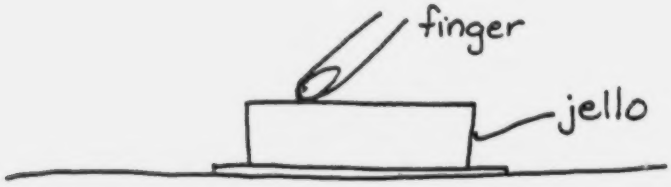
THIS IS MORE A CREATIVE EXERCISE ON DIFFERENT TYPES OF MYTHS THAT COULD CAUSE EARTHQUAKES. THE IDEA THAT STUDENTS SHOULD ALL DEVELOP IN THEIR ESSAY IS THAT PRESSURE IS BUILDING UP. IF GEOS CAN BECOME LIQUID, THEN CRACKS IN THE EARTH CAN DEVELOP (VOLCANOS) AND GEOS CAN ESCAPE. NOTE THAT THE CRACKING IN THE EARTH CAN MEAN EARTHQUAKES.

name _____

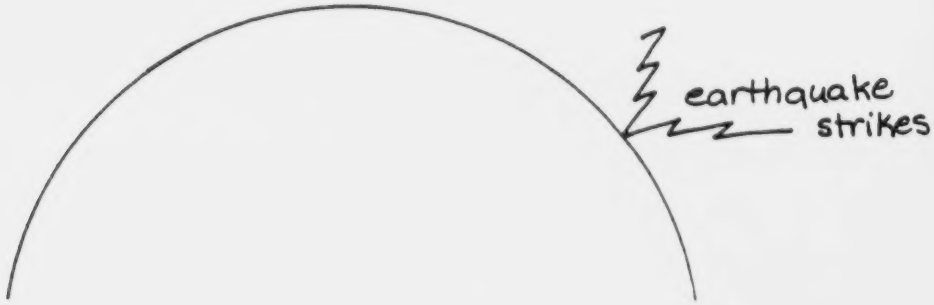
There is a friendly monster inside the earth. Geos wants to get out, but he doesn't want to hurt any living creature on earth. How can he get out without hurting anyone? Geos can change to any shape that he wants. He can become liquid also.

name

1. There is a bowl full of jello on the counter. What happens when you touch the top of the jello? Draw it.



2. What happens inside of the earth when an earthquake occurs? Draw it.



TEACHER SHEET

IN JELLO YOU CAN SEE THE MOVEMENT THROUGHOUT. SAME THING OCCURS INSIDE THE EARTH.

name

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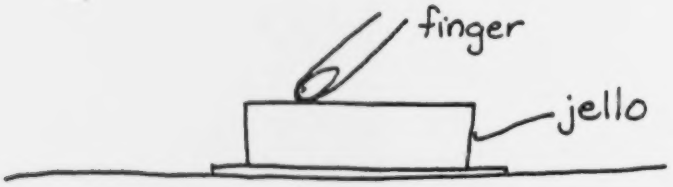

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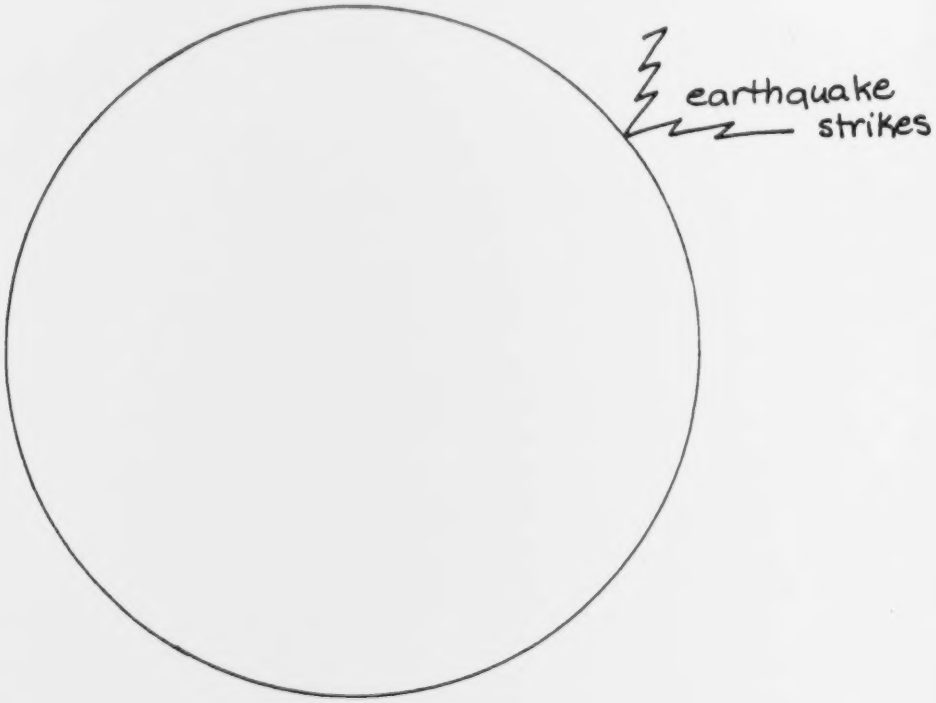
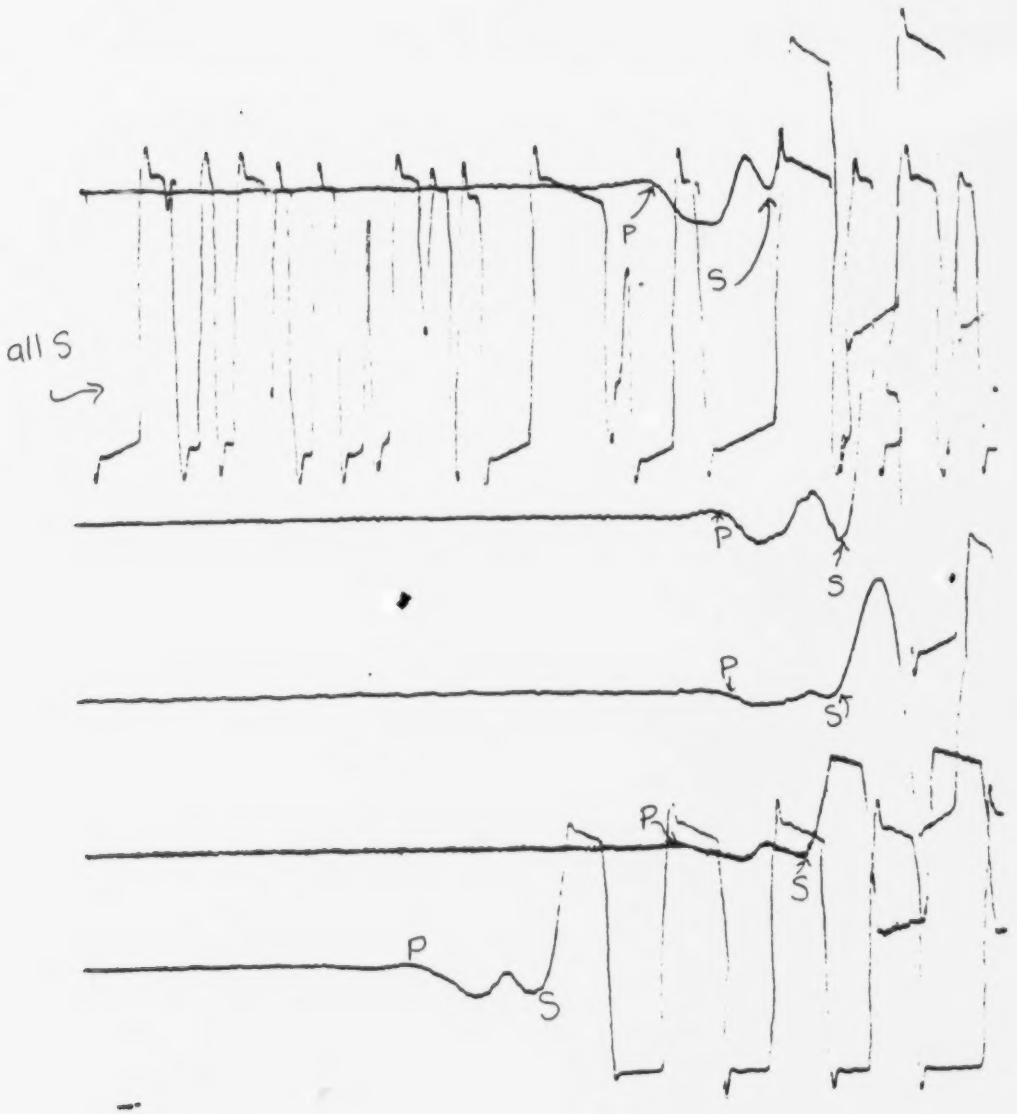


name_____



TEACHER SHEET

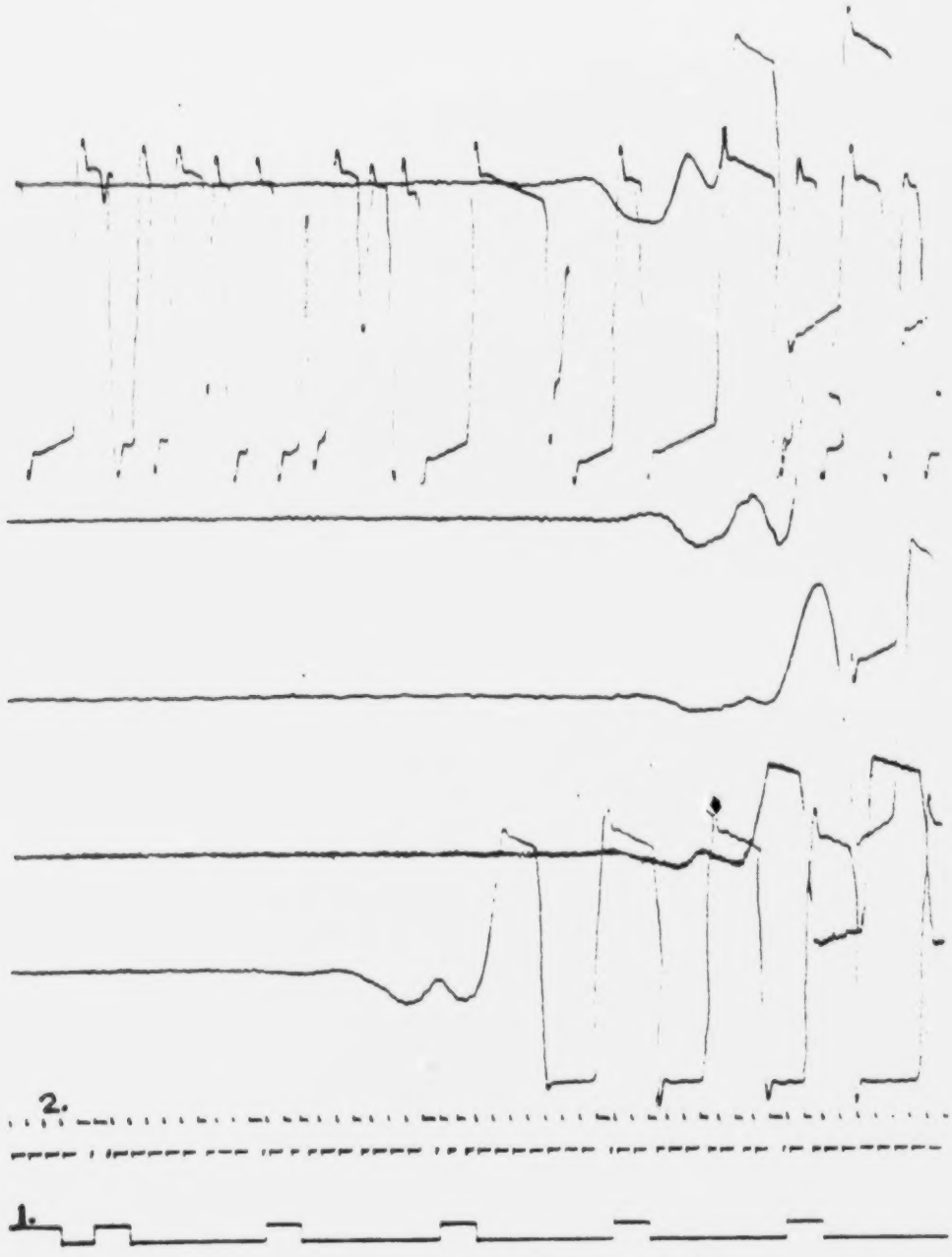
THIS IS A COPY OF A REAL SEISMOGRAM. STATIONS NEAR MAMMOTH LAKE, CALIFORNIA PHONED IN THEIR READINGS TO A MAIN COMPUTER AT THE MENLO PARK, CALIFORNIA OFFICE. SCIENTISTS WILL THEN TAKE THE DIFFERENT READINGS TO DETERMINE WHERE EXACTLY THE EARTHQUAKE TOOK PLACE. NOTICE THAT DIFFERENT LOCATIONS DO NOT RECEIVE THE WAVES AT THE SAME TIME DUE TO DIFFERENT TRAVELING DISTANCES.

1. How many stations are there? 6

2. Place a P where primary wave starts at each station?
   Place a S where secondary wave starts at each station?

3. What do lines 1 and 2 represent? TIME

name _____



about a 3.0 magnitude (Richter scale)

Mammoth Lake area, CA

1. How many stations are there? _____

2. Place a P where primary wave starts at each station?
   Place a S where secondary wave starts at each station?

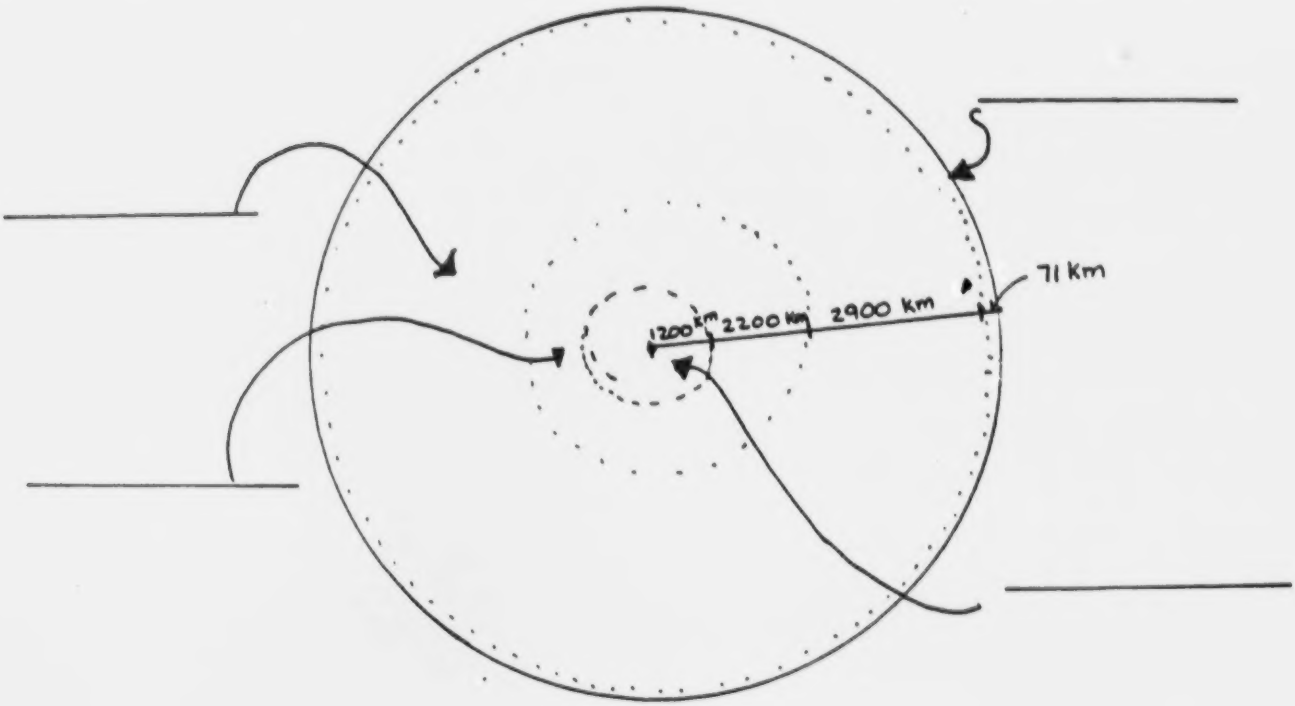
3. What do lines 1 and 2 represent? _____

_____

name _____

TEACHER SHEET

HAVE THE STUDENTS ADD UP COMPONENTS THAT MAKE UP RADIUS AND DIAMETER.

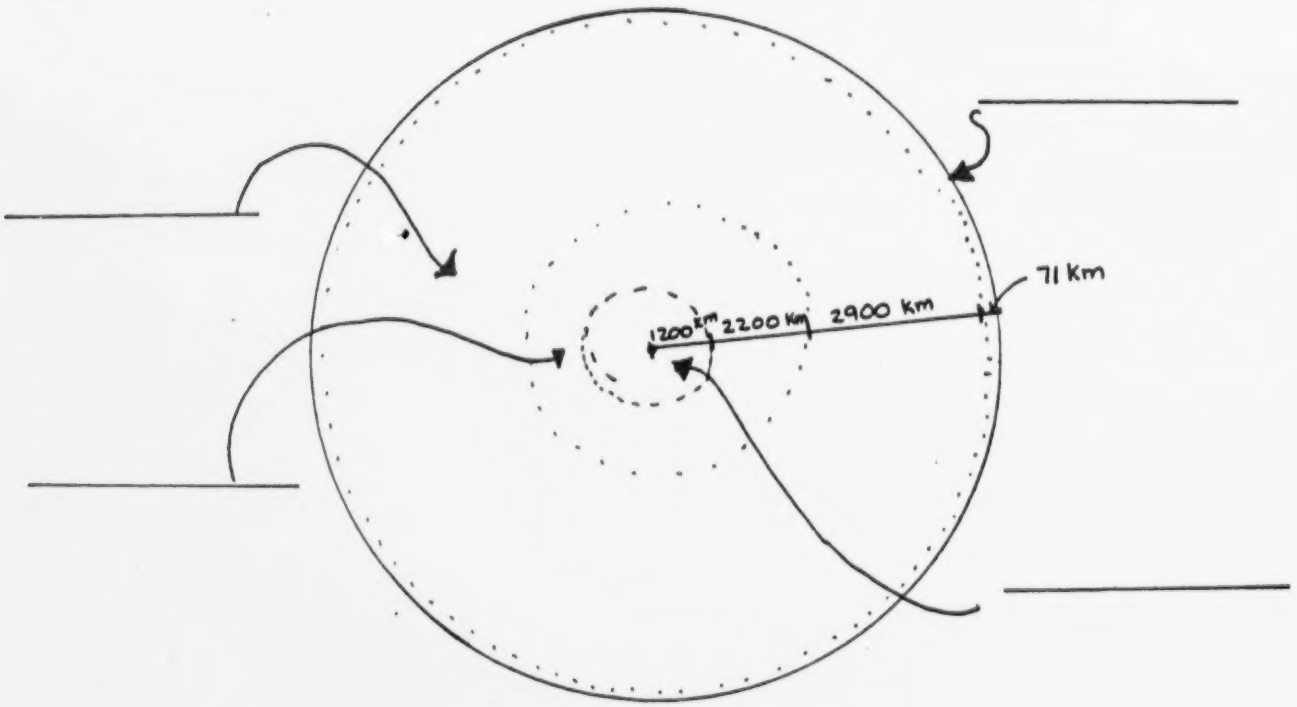


1. What is the radius of the earth?
2. What is the diameter?

Label the appropriate division of the earth by using the following clues.

Mantle - the largest division, between the core and crust
Inner core - the core of an apple is located here
Outer core - between inner core and mantle
Crust - the outer shell of earth

name _____



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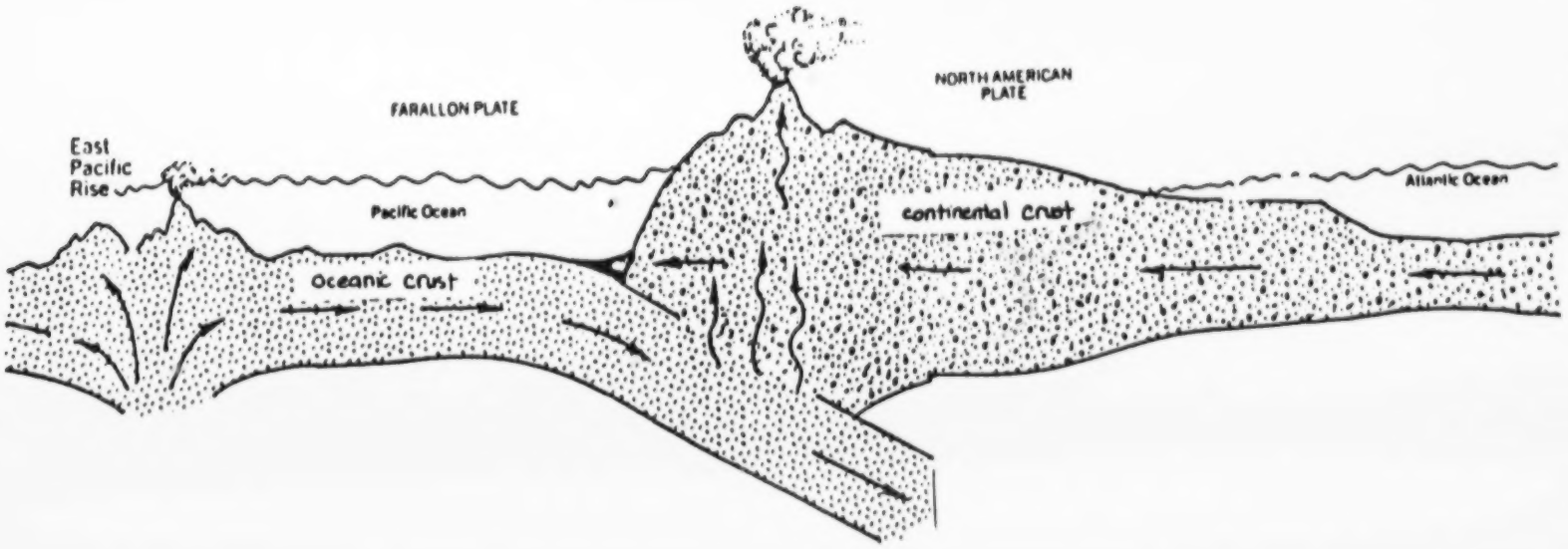

Convection currents inside the earth help move outer crust of the earth. What happens when convection currents meet

(↻↺) = converging or when they move away ↺↻

d

Place a D in the areas that are diverging and C in the areas that are converging in the above diagram of the earth.

TEACHER SHEET

WHEN CONVERGING OCCURS WE GET WHAT IS CALLED SUBDUCTION. WHEN THE MOVE AWAY YOU GET A RIFT VALLEY, OR VOLCANOS. YOU CAN DEVELOP THE IDEA OF PLATES, OR THAT PART OF THE CRUST THAT IS DIVIDED BY EARTHQUAKES AND VOLCANOS. ANOTHER EXERCISE MIGHT INCLUDE THE PLOTTING OF EARTHQUAKES AND VOLCANOS TO TRACE THESE PLATES.

name _____

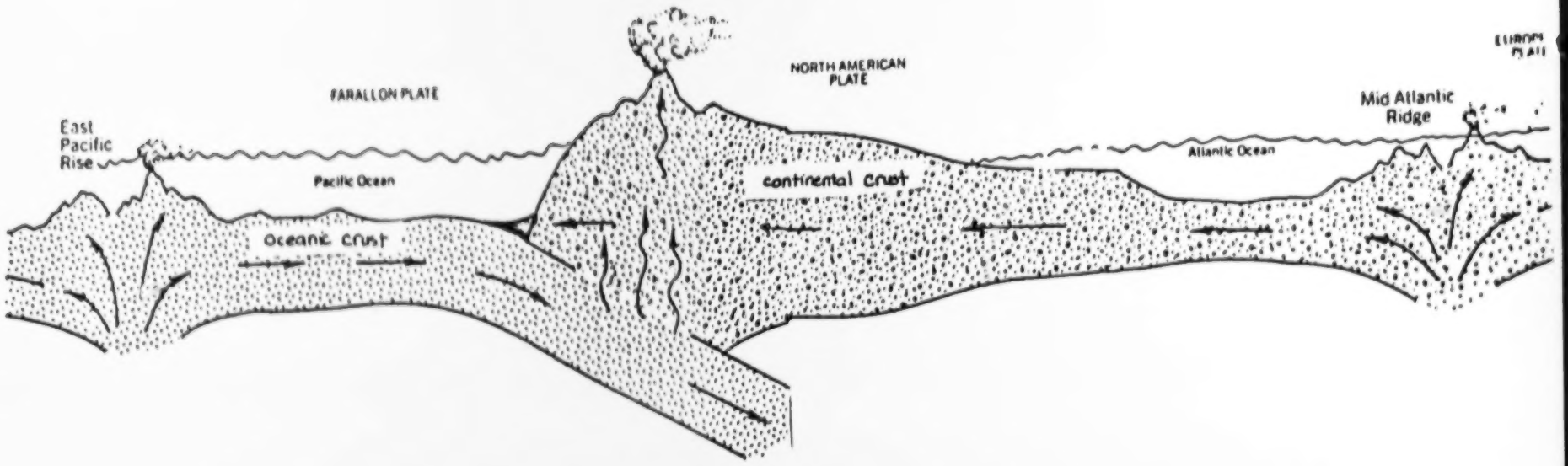

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PLATE TECTONICS CYCLE

VOLCANOES

The study of volcanoes does not encompass alot of subject matter. However, children are fascinated with the spectacular eruptions that occur throughout the world. In geology, volcanoes are very important to help interpret what is going on, inside the earth. Volcanoes have played an important part of the developing earth. As the new earth developed, volcanoes helped to create steam, which latter became the major source of water on this planet. In the lower primary grades recognizing the various shapes that volcanoes can be and that volcanoes produce igneous rocks should be emphasized. In the upper primary grades, learning where volcanoes are and plotting them on a map will help them to understand the plate tectonic unit.

LOWER PRIMARY

A. HOW MANY VOLCANOES ARE THERE? - How do the different types of volcanoes grow? Do all volcanoes produce lava? Compare and contrast the different types of volcanoes?

B. CREATING ROCKS FROM COOLING LAVA? - What type of rocks are formed from volcanoes? Does cooling affect the type of rocks formed? Are there different types of volcanic rocks?

UPPER PRIMARY

C. DISTRIBUTION OF VOLCANOES - What is an active volcano? What is a dormant volcano? What and where is the ring of fire? What is the difference between volcanoes in the Pacific with those of the Atlantic? What legends and myths have been created dealing with volcanoes?

D. PLOTTING WHERE VOLCANOES ARE - Where are the volcanoes located on the different continents and oceans? Is there a pattern? What could cause this pattern?

How do different types of volcanoes grow?

TEACHER SHEET

As volcanoes form, they produce a variety of shapes. Small children need to be exposed to the different types of forms that can be created. The sooner they can observe the development of shapes, the earlier they can begin to understand the growth of volcanoes.

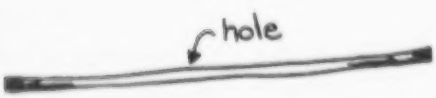
MATERIAL: a piece of cardboard with a hole, a paper cone cup with hole on top, shaving cream or whip cream under pressurized can

ACTIVITY: Squirt either the shaving cream or whip cream through the holes. Vary the pressure at which you do it and also the duration. Have students talk about the shapes.

You will have created different shapes...what will the children think of your creation? Ask them if the cream is growing? Ask them, why isn't the shape turning into a ball or going straight into the air?

Main concept for children to learn is that the cream represents the lava coming from a volcano. Lava comes out of the earth at different speeds. Lava forms a mountain like shape.

After getting this simple concept across...have the children play with the cream (whip cream...can surely be eaten).



↑ shaving cream or whipped cream

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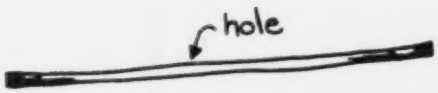

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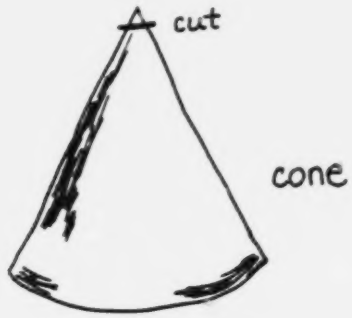

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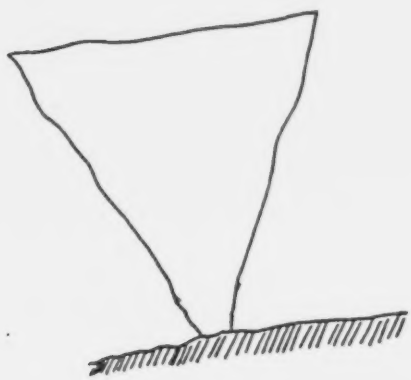
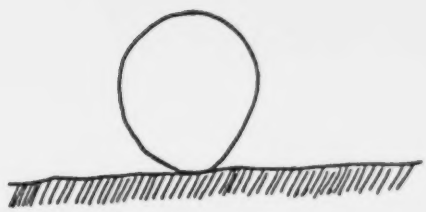
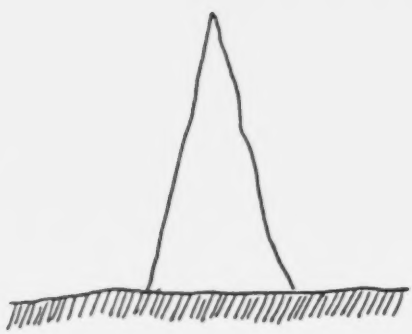
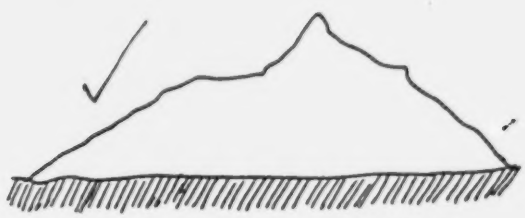
name teacher sheet

Circle shapes that a volcano can make.







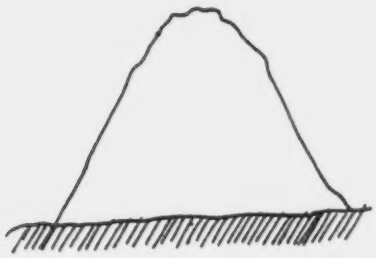


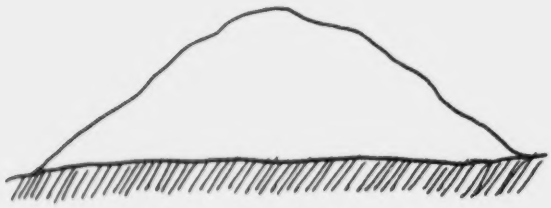
Why?

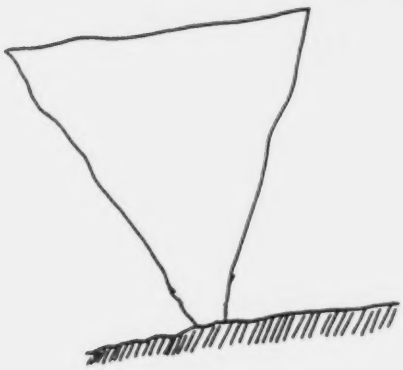
Main concept for children: Lava is a thick liquid (like honey). When it comes out of the ground it flows and builts a mountain shaped structure. Gravity and how thick the lava is depends on the shape. Children however, don't have to be introduced to gravity at this point.

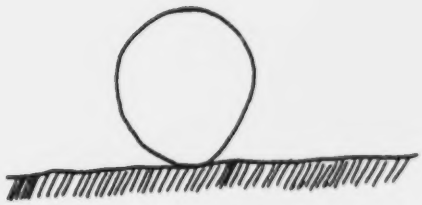
name_____

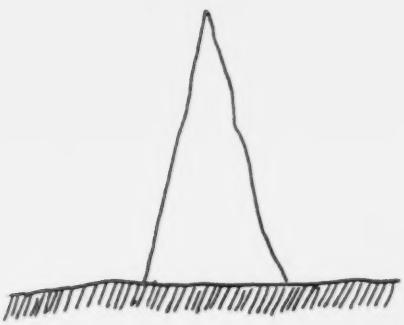
Circle shapes that a volcano can make.









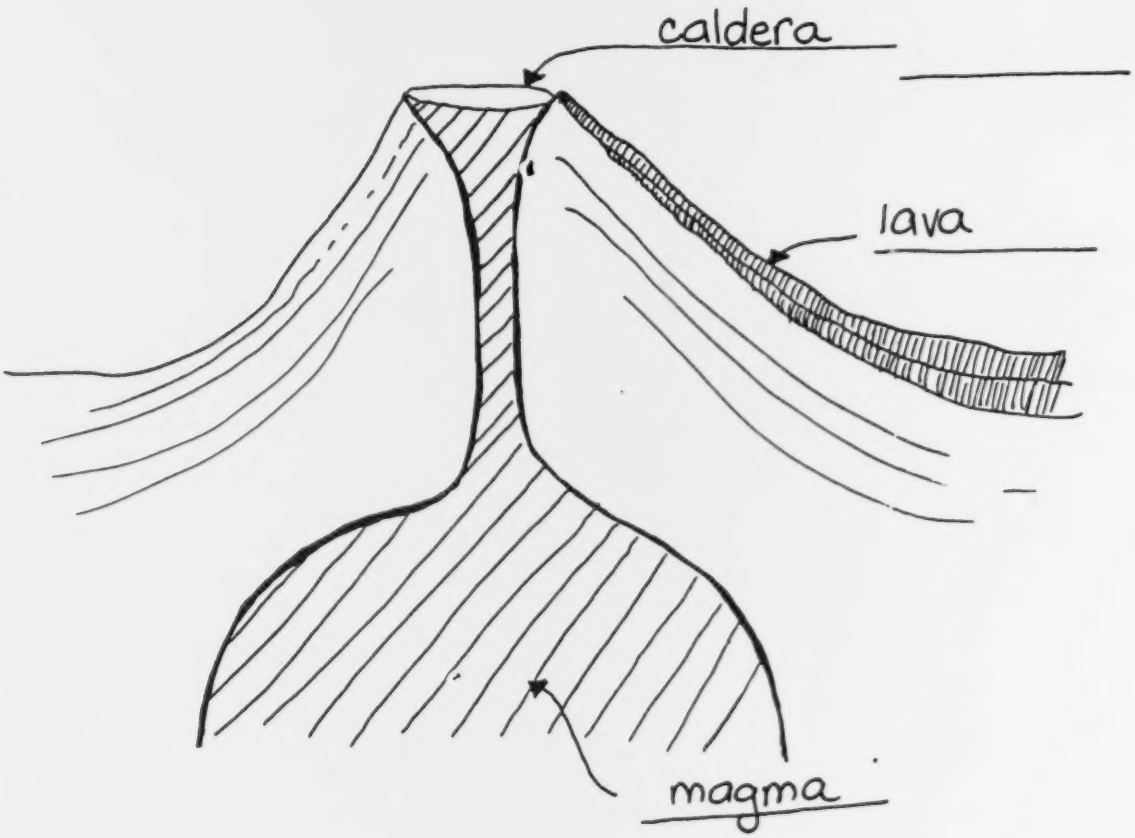


Why?

name teacher sheet

Main concept for children: Hot molten rock is called magma when it is inside the earth and lava when it reaches the surface. The opening of a volcano is called a caldera. Caldera in Spanish means the opening of a volcano.

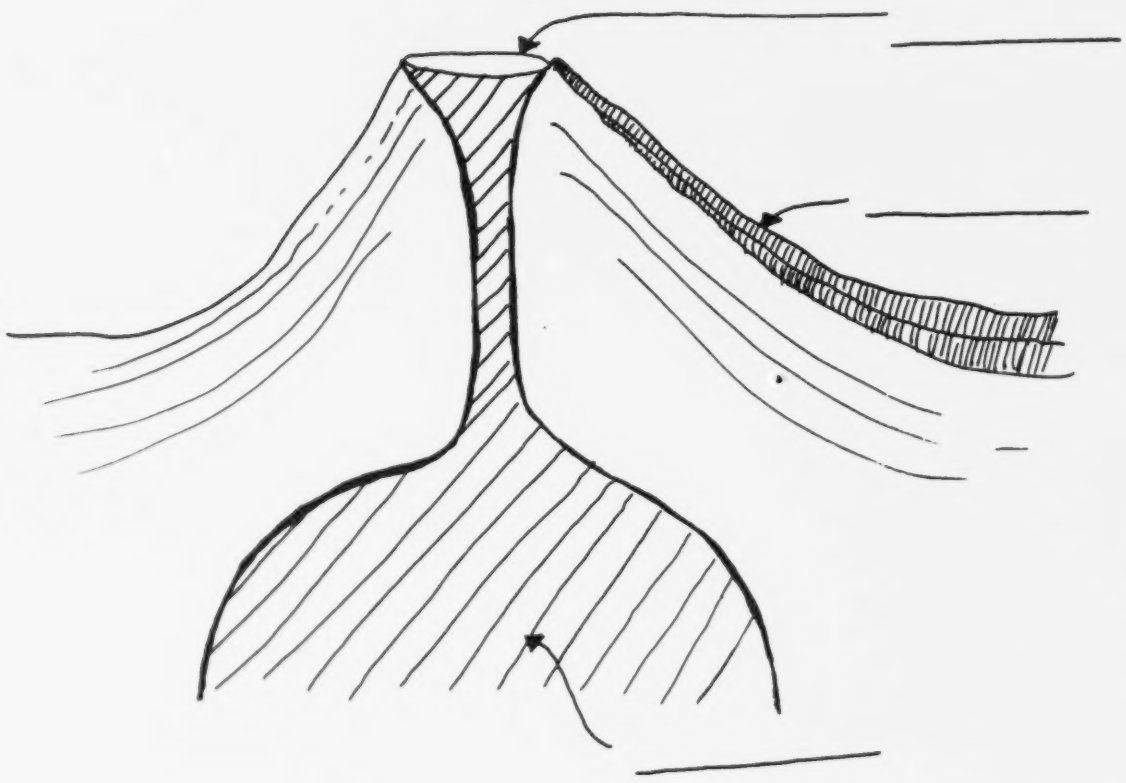
Ask the children if there is a difference in the hot molten rock. The answer is no ... geologist just give them separate names to know if the hot molten rock is inside or outside the earth.



What is this picture? volcano

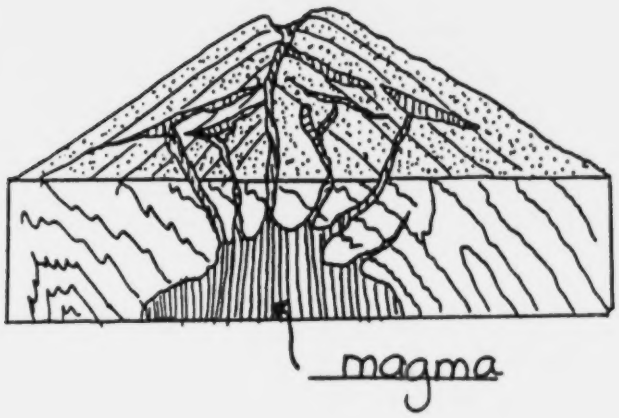
name _____

label the picture

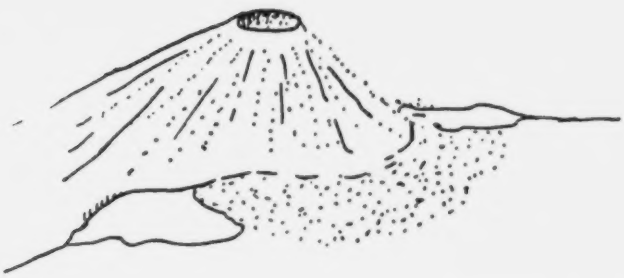


What is this picture? _____

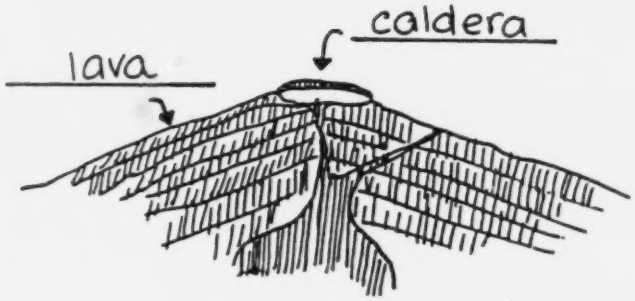
name teacher sheet



composite



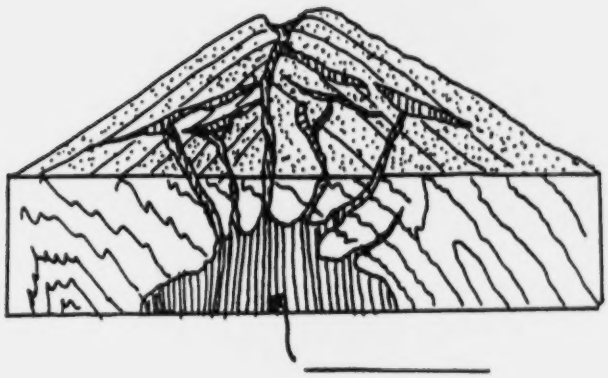
cinder cone



shield

Main concept for children: That volcanoes come in 3 different types. Shield volcano (ie. Hawaiian Volcanoes) are made up of lava that comes out of the volcano. Cinder cones (ie. Paricutin, Mexico) is made up of ash. The cone is much sharper than the shield...but it will erode very quickly because the ash is not a hard, hard rock. The composite volcano has a variety of components making up the sides of the volcano. Lava, ash, mud flows or whatever get trapped in an eruption (Mt. Shasta or Mt. St Helens is an example).

name _____



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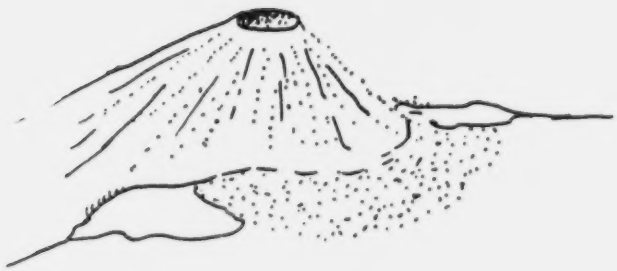

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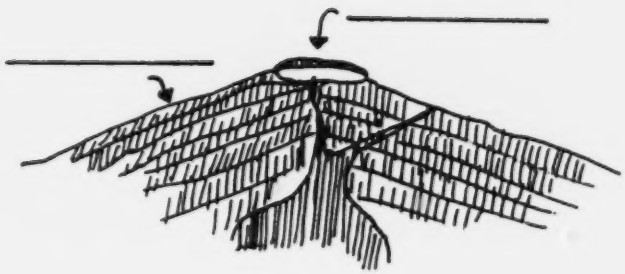


_____

Label: caldera
magma
lava
cinder cone
shield volcano
composite volcano

HOW TO MAKE AN EXPLODING VOLCANO

Materials: large flat wooden surface (2' by 2'), newspaper, plaster of paris, old plastic bucket, spray paint, empty tuna can, (or jar lid) ammonium dichromate (can be purchased from a chemical supply store). CAUTION: It's poisonous.

STEP 1. crumple up newspapers into balls and tape them to the wooden surface in the shape and size of the volcano you plan to build. See figure 1.

figure 1

STEP 2. mix (about 5 - 7 lbs) of plaster of Paris in the bucket with enough water to a pasty texture. Mold the plaster of Paris over the crumpled paper into the shape of a volcano. Place the tuna can inside the top of the volcano. See figure 2. NOTE...plaster of Paris dries very quickly. You have approximately 15-25 minutes to work with it before it becomes hard.

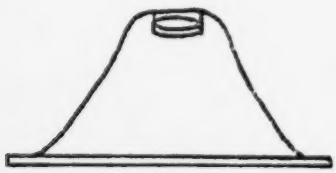


figure 2

STEP 3. allow the volcano to dry completely, then paint and create your own scenic location.

STEP 4. Exploding the volcano requires you to place about 3 tablespoons of ammonium dichromate into the depressed area of the volcano, hold a match to it until it ignites, turn off the light sand observe, listen and smell. For a quick easy clean up use vacuum cleaner. (CAUTION...THE CHEMICAL AND ITS ASH ARE POISONOUS! IF STUDENTS COME IN CONTACT WITH IT HAVE THEM WASH IT OFF IMMEDIATELY.) Place newspaper over the entire area where demonstration is to take place to avoid a mess.

HOW TO MAKE A VOLCANO

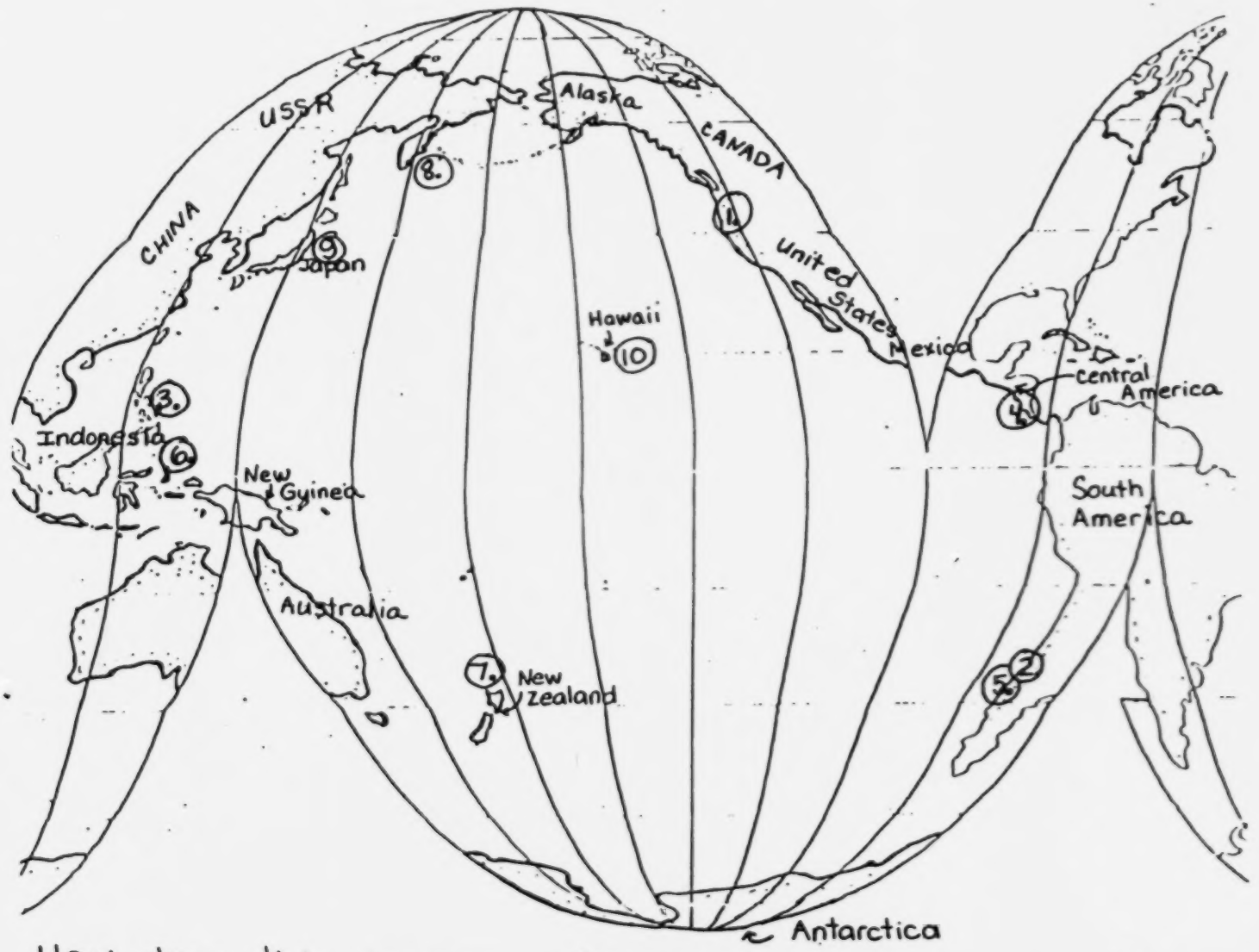
What do you do after you explode the volcano?

Explain to the children that the explosion was a model of how a volcano erupts. Not all volcanoes, but some of them. Emphasize that volcanoes are not all the same. Draw a graph to show them how you can compare the model with a real volcano.

Model	Mt St. Helens	Hawaii
emits gas	emits gas	emits gas
smells	has sulfur oder	has sulfur oder
fire	no fire (no lava)	red hot lava
ash builts a cone	ash builts a cone	little or no ash
sound	violent eruption	quiet eruption

name _____

Plot recent eruptions of volcanoes on world map.



How does this compare with volcanoes of the world

This exercise should get students to read the little fact article and then to be able to figure out where the eruption is on the map and then to plot it.

How does this compare with volcanoes of the world? All these volcanic eruptions fall into the RING OF FIRE in the Pacific Ocean. See world distribution of volcanoes.

Recent Eruptions
1984 - 1985

1. **May 14**—Ejection of gas and tephra at Mount St Helens; deformation, seismicity and gas emission had declined to background levels after the extrusion episode in late March (see June *Geotimes*); seismicity began to increase a few minutes before a gas and tephra plume was seen rising to about 6 km altitude; light ashfall was reported at Mount Rainier National Park, 65 km north-northeast; cold to hot (but not molten) material was ejected from the upper southwest part of the dome; some cleared the rim of the crater and fell on the outer west flank of the volcano, but much of the material struck the west wall of the crater, melting snow; a flow consisting of 90% snow and 10% sand-size fragments of old lava and a few blocks as large as 1 m in diameter moved through the breach in the north side of the crater and divided into 2 branches; the northeast branch, mostly clear water, reached Spirit Lake (5.5 km from the crater), while the northwest (main) branch, a mudflow, entered the North Fork of the Toutle River.

2. **April 20**—Eruption of Llaima (Chile); dense columns of dark ash rose from the central crater and were observed from Temuco, 70 km west of the volcano; tourists and residents of the area immediately around the volcano were evacuated and vehicle traffic was restricted. Llaima's last known eruption was Oct. 15-Nov. 24, 1979, with several explosions and brief emissions of ash and small amounts of fresh lava over the volcano's snow-covered slopes.

3. **May 15**—Eruption of Pagan (Mariana Islands); at 0825 residents of Agrigan Island (65 km north of Pagan) felt an earthquake, rushed from their homes, and saw a dark column rising 2 to 4 km above Pagan; the 50-km diameter eruption cloud drifted northwest; no lava flow could be seen from the Air Force weather reconnaissance plane diverted to inspect the activity; a second moderate eruption occurred during the afternoon. Pagan had emitted a small moisture-laden plume on about half the days since the end of March (see July *Geotimes*).

4. **Early June** (and continuing)—Increased explosive activity at Arenal (Costa Rica); ash fell 10 km southwest of the vent and most explosions ejected large incandescent blocks; lava production has been nearly continuous since the eruption began in 1968, but the increased explosive activity coincided with a clear diminution in the rate of advance of the active south-flank lava flow.

5. **Aug. 11**—Eruption of Villarrica (Chile); during the afternoon, 3 strong explosions and underground rumbling preceded the emission of a dark ash column that rose 200 m above the summit; ash was deposited on the southeastern snow-covered slope of the volcano; increased seismicity was recorded during the eruption. During Villarrica's last eruption, in October 1983, explosive activity ejected tephra and produced pyroclastic flows (see January *Geotimes*).

6. **Aug. 31**—Explosive eruption of Soputan (Sulawesi, Indonesia); a progressive increase in local seismicity began Aug. 6; a sequence of tremors of increasing amplitude occurred Aug. 14; a warning was issued to civil authorities, and a public alert was put into effect that day; seismicity continued through Aug. 25, but stopped between then and the time of the eruption; the 5-hour eruption began in the early morning of the 31st; an ash column rose to about 6 km and moved northeastward; the ash cloud covered a large area and disrupted traffic on the trans-Sulawesi highway.

7. **Late October**—Small ash eruption from Ruapehu (New Zealand); in early October, crater-lake temperatures had dropped to the lowest level since detailed measurements began, but seismicity increased (see January *Geotimes*); sulfur upwelling in the lake resumed in mid-October and temperatures began to rise; ash was ejected from the lake in late October, forming a thin patchy layer extending about 500 m to the south. Ruapehu's last eruption was a similar minor ash emission in October 1980 (see January 1981 *Geotimes*).

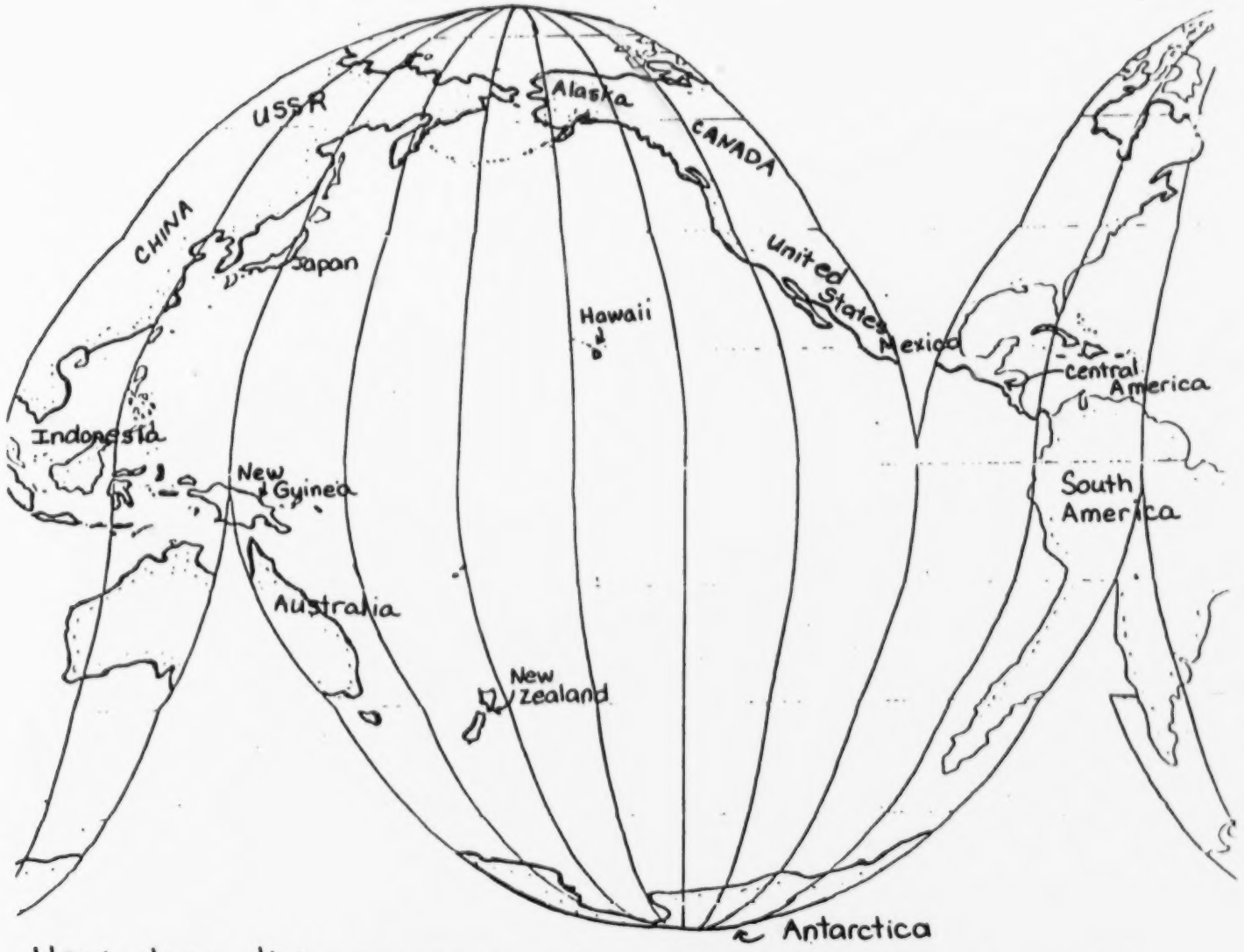
8. **Dec. 27-Jan. 8**—Eruption of Gorely Khrebet (Kamchatka, USSR); clouds from initial phreatic explosions reached a height of 3.5 km; ash explosions began Dec. 30; plumes rose to 3 km high and extended 100 km to the east; the eruption ended Jan. 8. Gorely Khrebet last erupted June 1980-July 1981, when numerous explosions ejected tephra from the central crater.

9. **Jan. 2** (and continuing)—Eruption of Aso (Kyushu, Japan); weak ash emission occurred Jan. 2-3 at Crater 1 of Nakadake, the historically active part of the Aso volcanic complex; an ash-laden plume was observed occasionally after Jan. 11; a grey plume rose 700 m above the crater rim Jan. 18; volcanic flames were observed the night of Jan. 21; the ash included juvenile material; weak tephra emission had occurred from a nearby fumarole on Oct. 24-25 (see February *Geotimes*).

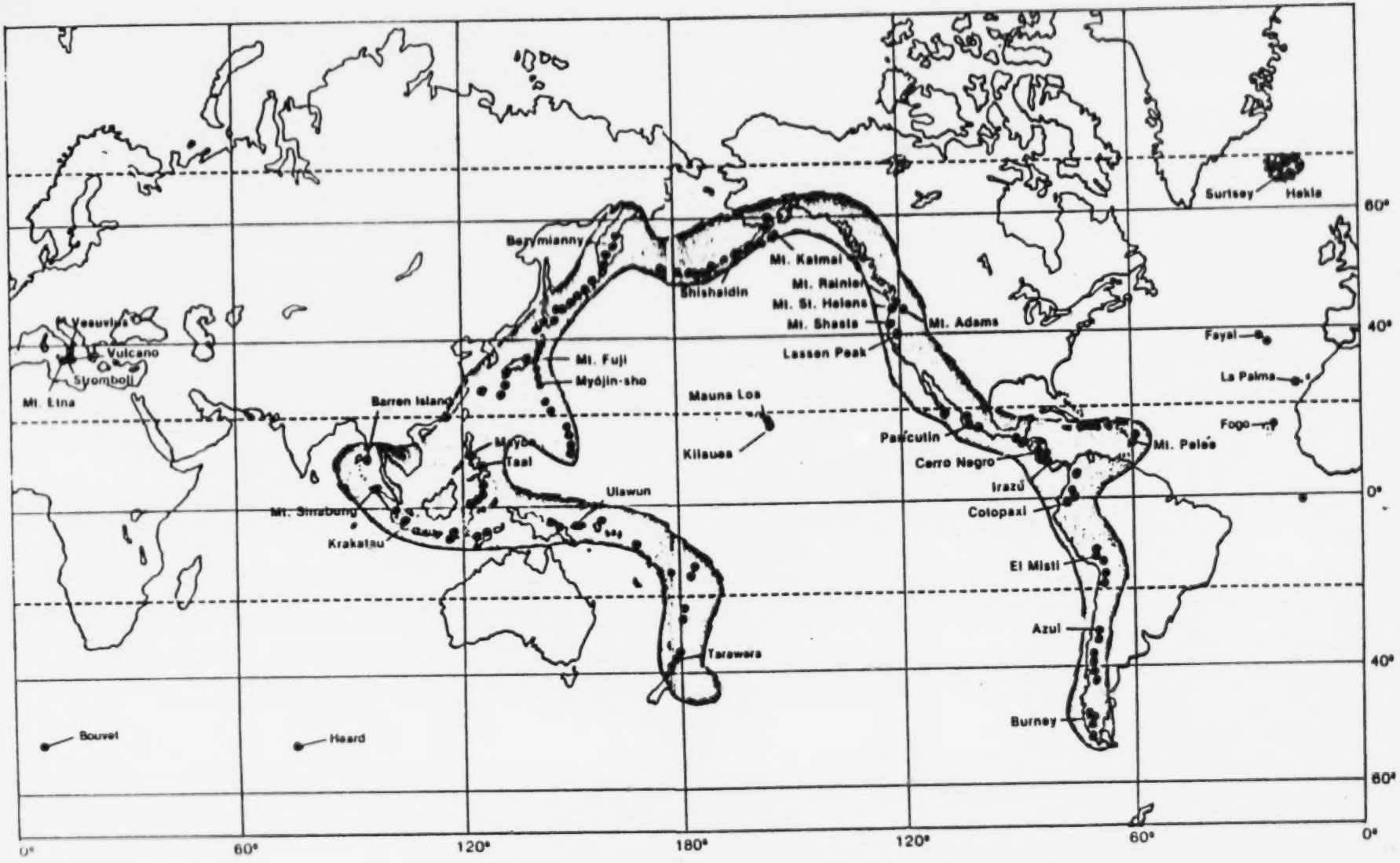
10. **Jan. 3-4**—29th major phase of the 2-year-long East Rift Zone eruption of Kilauea; during the early evening of Jan. 2, low lava fountaining was reported from the vent that had been active during previous phases; gradual summit deflation began late the next morning, about 2 hours before vigorous eruptive activity began; a marked acceleration of harmonic tremor started less than an hour later; lava fountains about 380 m high fed lava flows that extended east-southeast from the vent before eruptive activity stopped early the next morning; summit inflation characteristic of interphase activity resumed about 3 hours later.

name _____

Plot recent eruptions of volcanoes on world map.



How does this compare with volcanoes of the world



Volcanoes of the World

Why do we have volcanoes?

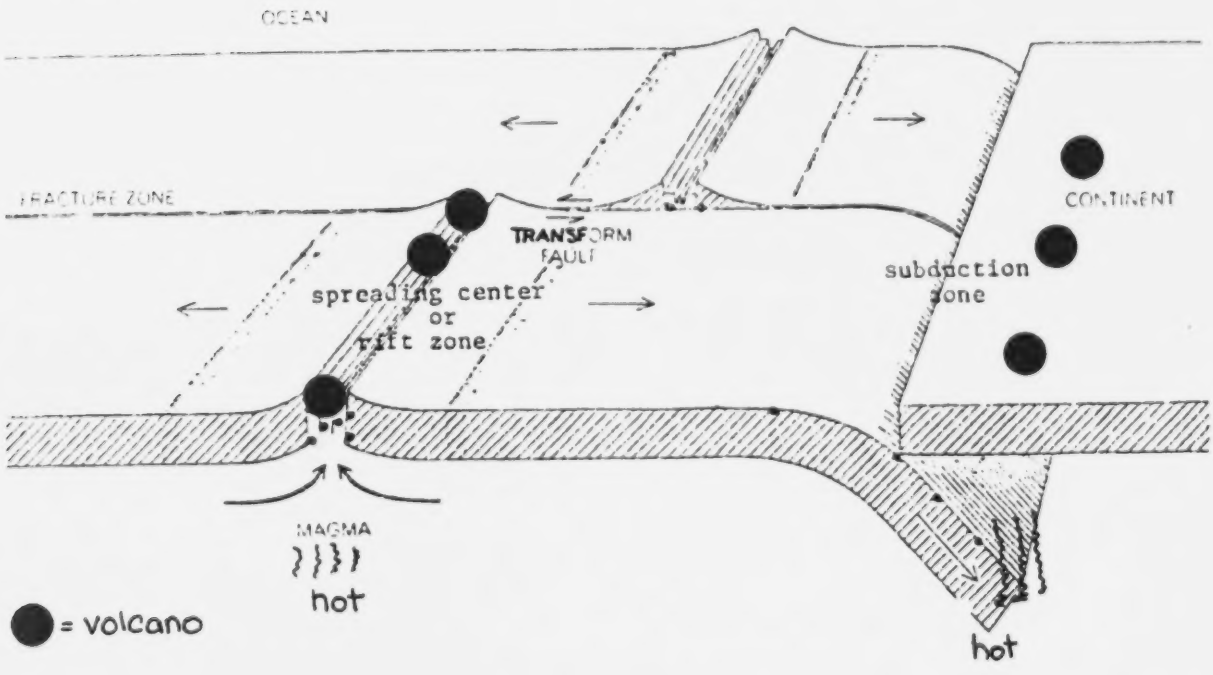
Students of cause will ask the question, Why do we have volcanoes? This subject will be discuss and explained more in the unit on Plate Tectonics. But you can explain it simply:

The surface of the earth moves.

The inside of the earth is very restless and it moves also.

Because the inside moves, the surface CRUST moves also. When it moves in one direction in one spot, it has to move the other way in another. The earth doesn't get bigger or smaller.

In the diagram below the crust can move in 3 ways. Apart (rift zone, spreading center, divergence); together (subduction, converging); or past each other (transform fault). These terms have many names, but this doesn't have to be explained in elementary school. We get volcanoes when hot rock is created. When the crust pulls apart and together, this is when we get volcanoes. (Remember hot rock is lighter then rock that is not molten and moves upward).



NAME teacher sheet

Write in the correct answer from the following words:

volcano	obsidian
magma	ash
lava	Hawaii
pumice	basalt
granite	Mt. St. Helens

1. Lava is hot, molten, or melted rock.
2. Lava that is still deep inside the earth is called magma.
3. Lava come up, out of a volcano.
4. Obsidian is a natural volcanic glass.
5. Pumice is a volcanic rock that is very light because it has so many little holes in it.
6. The state of Hawaii is a chain of volcanic islands in the Pacific Ocean.
7. Mt. St. Helens is an active volcano in Washington that erupted explosively on May 18, 1980.
8. Granite is an igneous rock that cooled slowly below the earth's surface. It is not produced by a volcano.
9. Most of Hawaii is made of basalt a fine-grained black rock.
10. When Mt. St. Helens erupted, it shot tons of powdery ash into the atmosphere.

NAME _____

Write in the correct answer from the following words:

volcano	obsidian
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1. _____ is hot, molten, or melted rock.
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PLATE TECTONICS CYCLE

PLATE TECTONICS

Plate Tectonics is just a fancy name for explaining how the outer crust of the earth has moved through time. Basically the continents that we recognize today, have not always been that large or in its present location. They have shifted and moved over the last 4.5 billion years. Geologists have looked at evidence that have confirmed the reality of Plate Tectonics. They have looked at fossils, magnetism, gravity, and a host of other disciplines that make this one of the most exciting fields in geology as they unravel the mysteries of the earth's interior. Teaching Plate Tectonics to elementary school students can be fun and exciting. The details of this discipline should be left for high school and college; but just the fact that our earth is moving is an exciting fact within itself. Lower Primary emphasizes the puzzle like shape of the present day continents. The upper primary establishes that earthquakes and volcanoes defines the boundaries of plates, as they move through time.

LOWER PRIMARY

A. DO OUR CONTINENTS FIT? - Does South America's coast fit with Africa's coast? Can you make a puzzle out of our continents? Can other clues help us unravel the the puzzle?

B. PRESSURE IN THE EARTH? - Why is there pressure inside the earth? How can it be released? What is the crust? Can the crust move?

UPPER PRIMARY

C. HOW ARE VOLCANOES AND EARTHQUAKES RELATED? - Do earthquakes and volcanoes occur together? What do earthquakes and volcanoes define? What is a plate? What is a plate boundary?

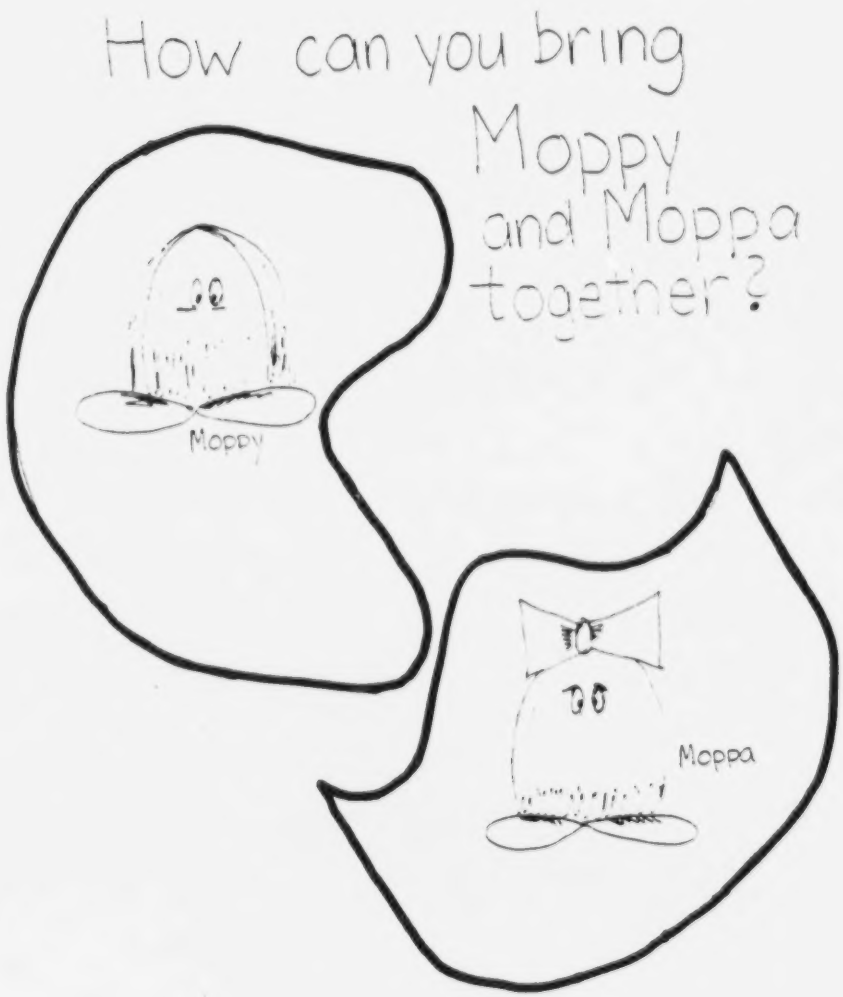
D. HOW DOES OUR CRUST MOVE? - What is geologic time? Can the earth move long distances? What are converging plates? What are diverging plates? Can plates just slip past each other?

TEACHER SHEET
KINDERGARTEN - PLATE TECTONICS

To understand plate tectonics students must be familiar with the globe. Point out the continents and oceans, by making the class repeat the names of them.

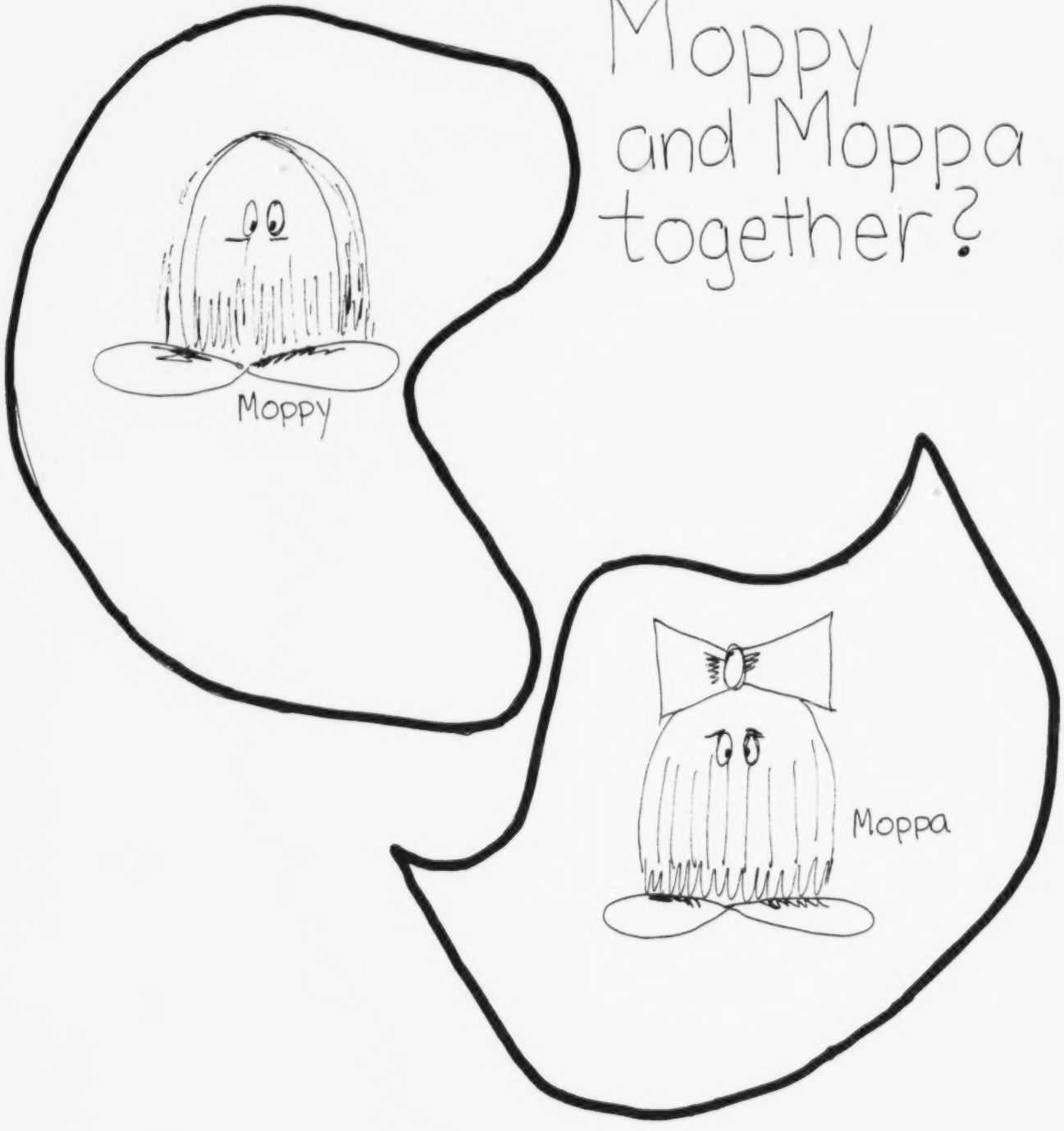
This exercise is to create a puzzle out of something that the students may not be familiar with. Have them color and cut Moppy and Moppa out and fit them together once again. You can create a story about Moppy and Moppa being on to different islands that broke apart when they had a fight. But now Moppy and Moppa have made up and want the island to be one again.

name _____



name _____

How can you bring Moppy and Moppa together?



TEACHER SHEET
FIRST GRADE - PLATE TECTONICS

This handwriting, coloring and cutting exercise has your students see that South America fits into Africa. Discuss with your students if this could really happen. Remember that this is not enough evidence to say that these continents were together once. You might want to discuss other evidence that might convince someone. The best piece of evidence would be to see if the rocks were similar...and sure enough, they are! Emphasize with your students that the continents have moved.

name_____

Color Africa and South America. Can you make a puzzle?

Cut them out and find out!

name _____

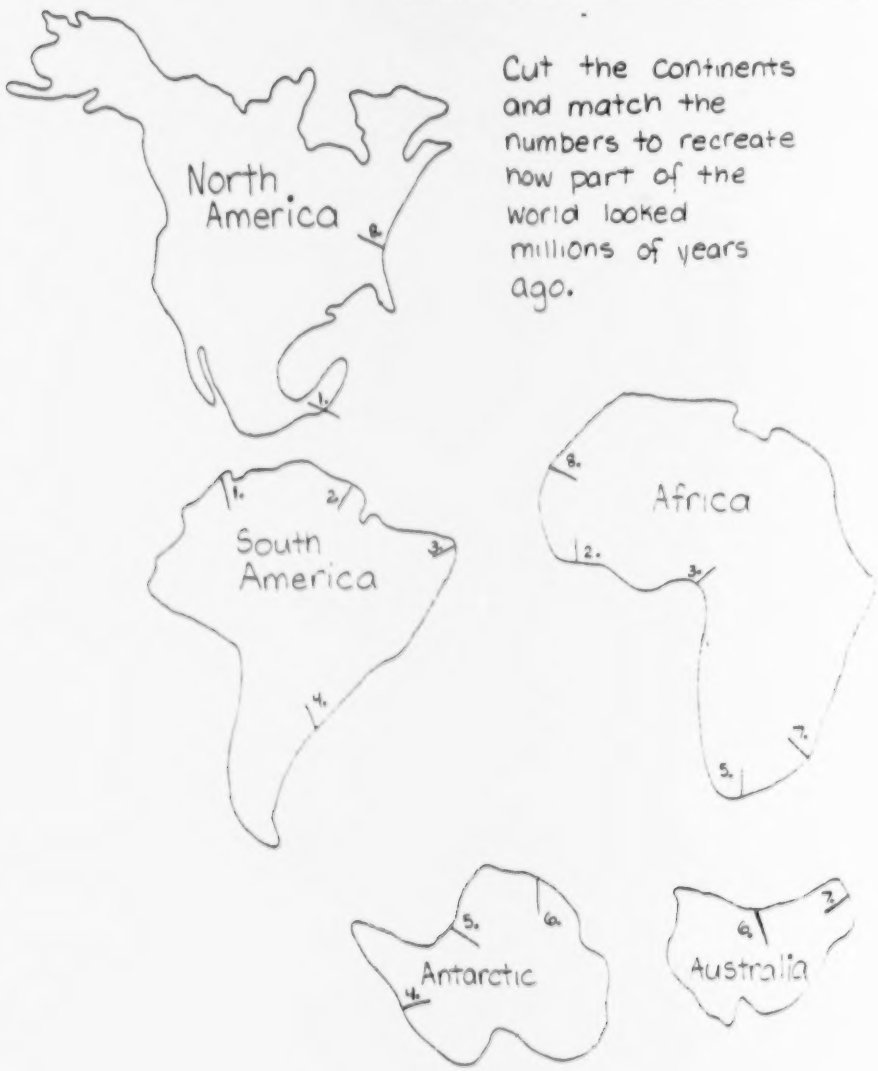
Color Africa and South America. Can you make a puzzle?

Cut them out and find out!

TEACHER SHEET
SECOND GRADE - PLATE TECTONICS

This exercise looks at the continents of North America, South America, Africa, Antarctic and Australia and how they moved over the last 200 or so million years. The lines and numbers try and make this puzzle a little easier. You may want your students to work in pairs...this is not as easy as it looks.

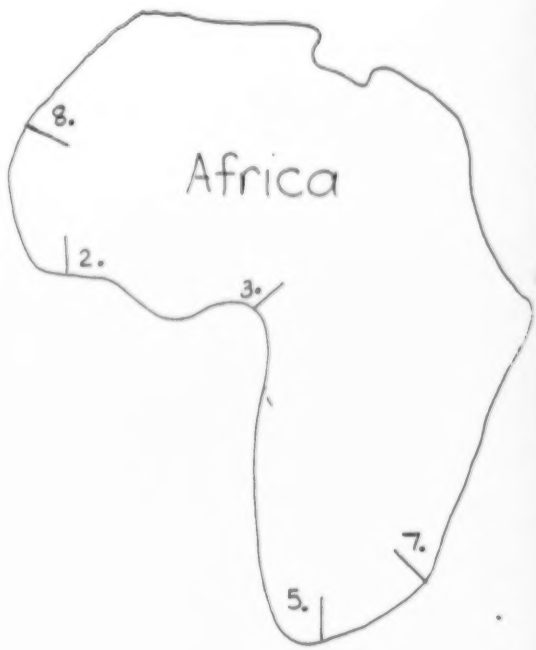
name _____

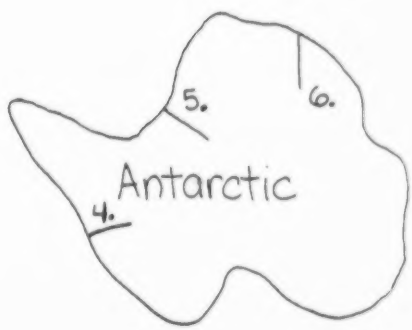


Cut the continents and match the numbers to recreate how part of the world looked millions of years ago.

name _____

Cut the continents and match the numbers to recreate how part of the world looked millions of years ago.





TEACHER SHEET
THIRD GRADE - PLATE TECTONICS

This diagram uses cartoon characters to illustrate how the inside of the earth controls what happens on the outside of the earth. Pressure man and Gut woman do not represent what is actually happen, but conveys the idea that in some places you have a pressure going one way and in another place the pressure is going the opposite direction. The outside of the earth or the crust reacts and is either "pulled apart" or "eatened."

name _____

When pressure man pushes upward from the inside of the earth he causes the crust to move apart (diverge) above him. But woman eats the crust (converge) as pressure man pushes away.

- Draw pressure man and Gut woman inside the earth.
- Draw a circle where the crust move apart (diverge).
- Draw a triangle where the crust is eaten (converge).

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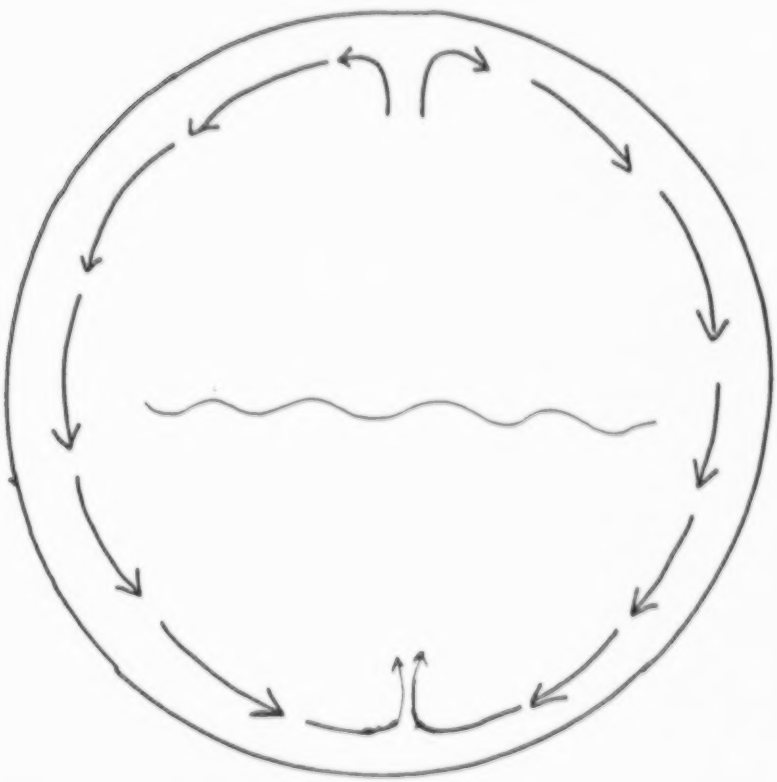
name _____

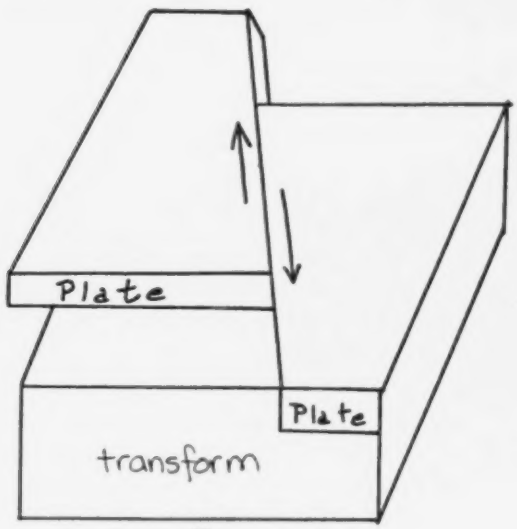
When pressure man pushes upward from the inside of the earth he causes the crust to move apart (diverge) above him. But woman eats the crust (converge) as pressure man pushes away.

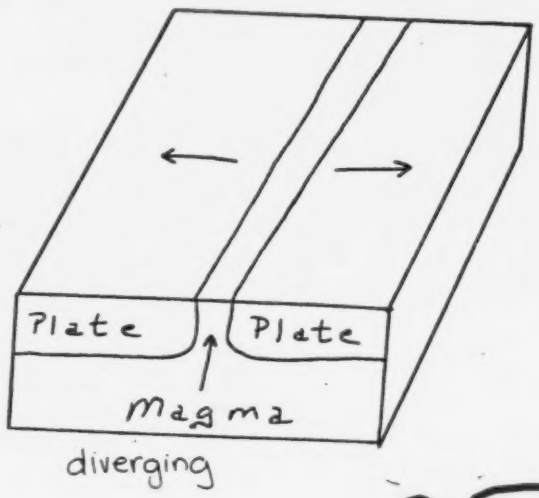
* Draw pressure man and but woman inside the earth.
* Draw a circle where the crust move apart (dwerge).
* Draw a triangle where the crust is eaten (converge).

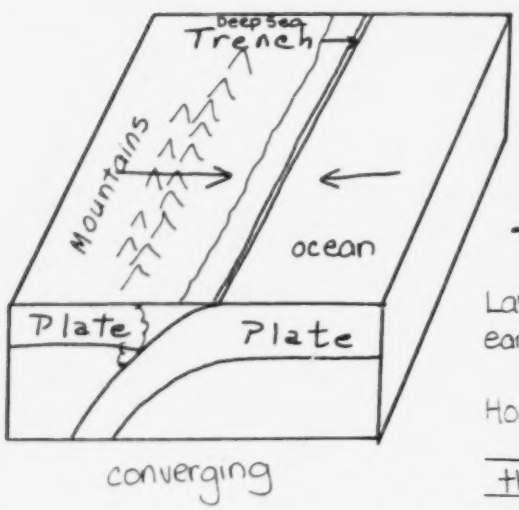


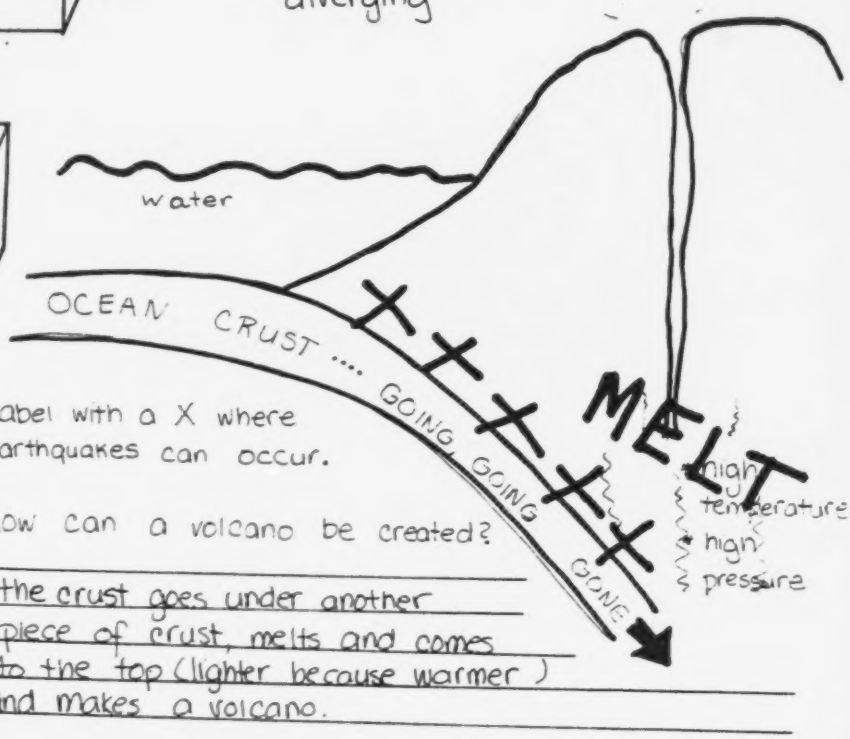
TEACHER SHEET
FOURTH GRADE - PLATE TECTONICS

Earthquakes and volcanoes are related because they reflect opposite directions of a moving crust. For example, the crust can be pulled apart (diverge), moved toward each other (converge) or slip past each other (transform). In the fourth grade emphasis should be that the crust has different pressures on it and it either creates a volcano or an earthquake or both. You can make an analogy that people burp because they have a pressure inside them...well the earth has pressure in it too! The earth spells relief....EARTHQUAKE or VOLCANO!









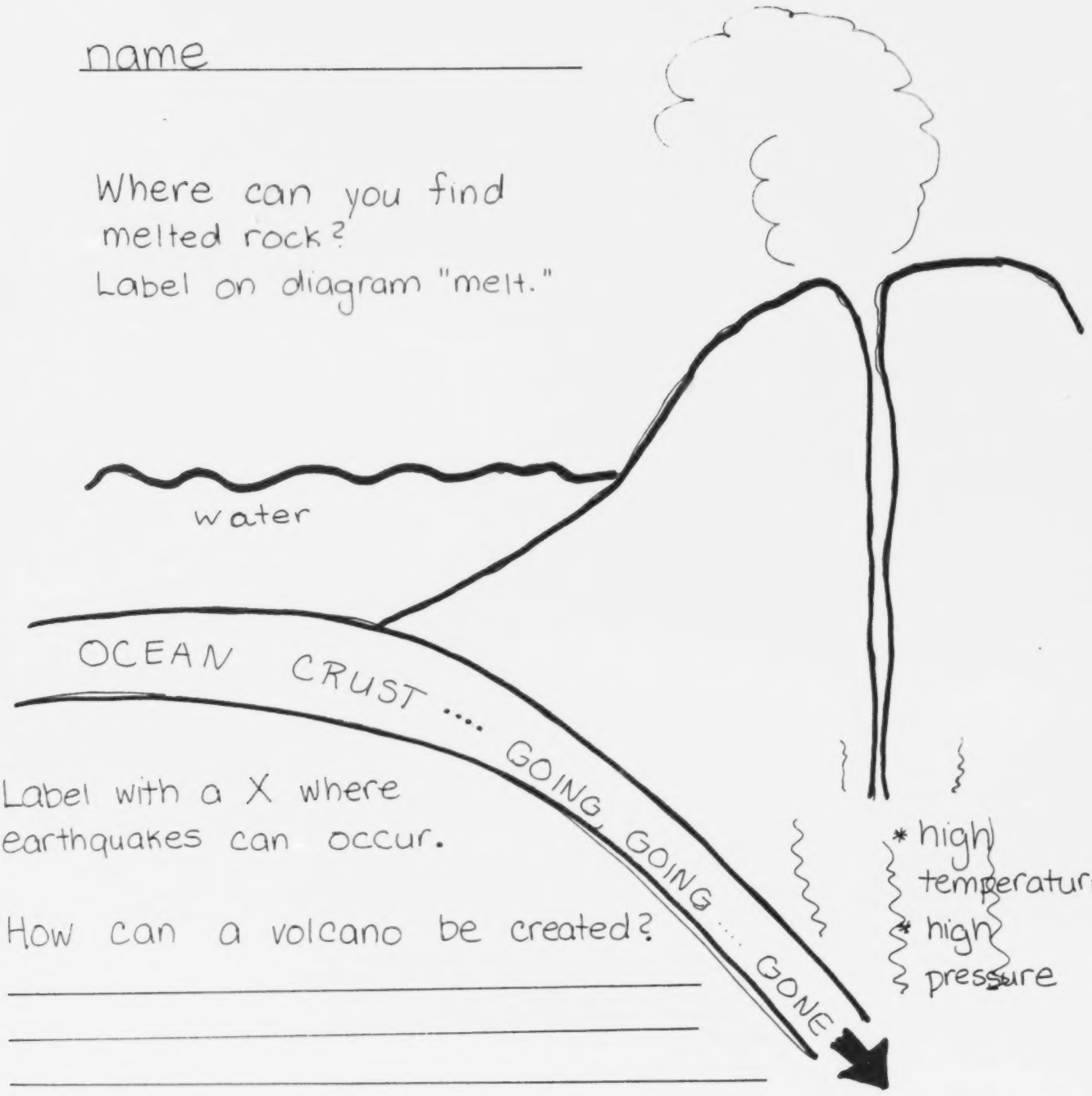
Label with a X where earthquakes can occur.

How can a volcano be created?

the crust goes under another piece of crust, melts and comes to the top (lighter because warmer) and makes a volcano.

name _____

Where can you find melted rock?
Label on diagram "melt."



Label with a X where earthquakes can occur.

How can a volcano be created?

_____

_____

_____

_____

_____

_____

_____

_____

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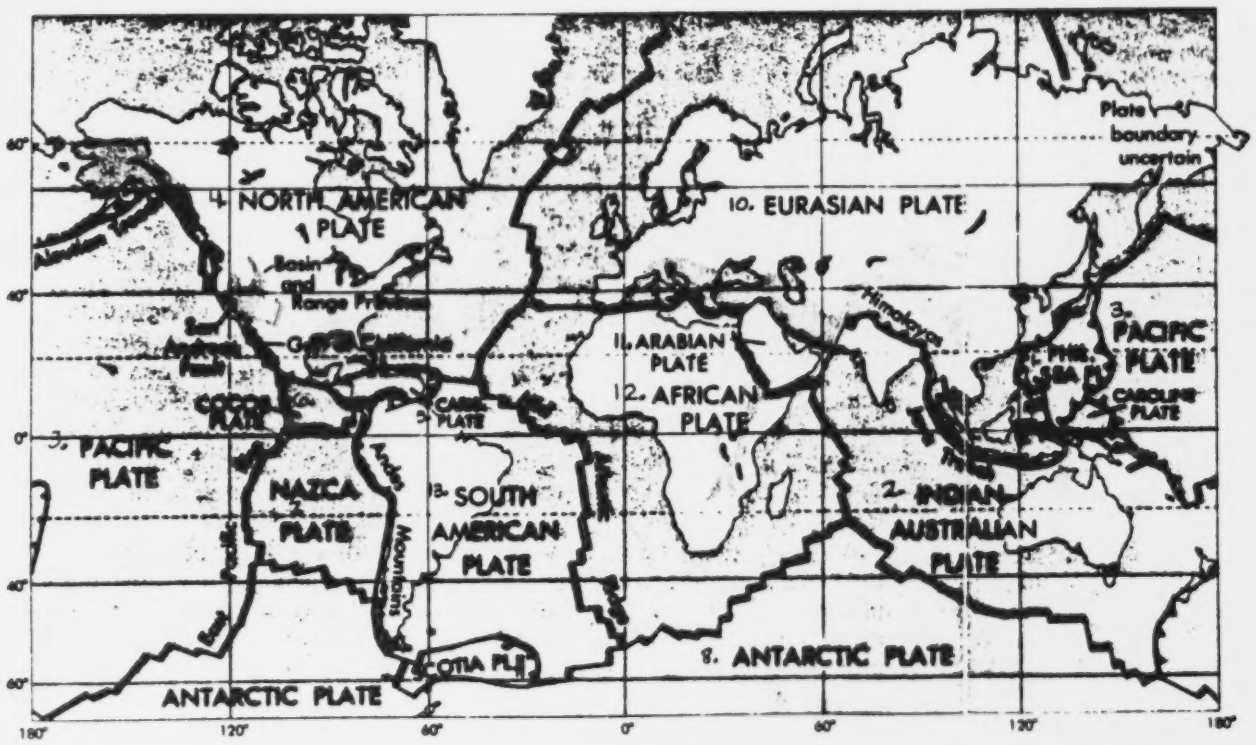
TEACHER SHEET
FIFTH GRADE - PLATE TECTONICS

This exercise is just to introduce that the crust breaks into plates. It is difficult to understand the mechanisms behind plate tectonics in the elementary school. Just introducing the concept of plates is sufficient enough to start the process of fully understanding plate tectonics. Most of the names derived are based on the major continents that are located on the plate; other names are historical.



from U.S. Geological Survey

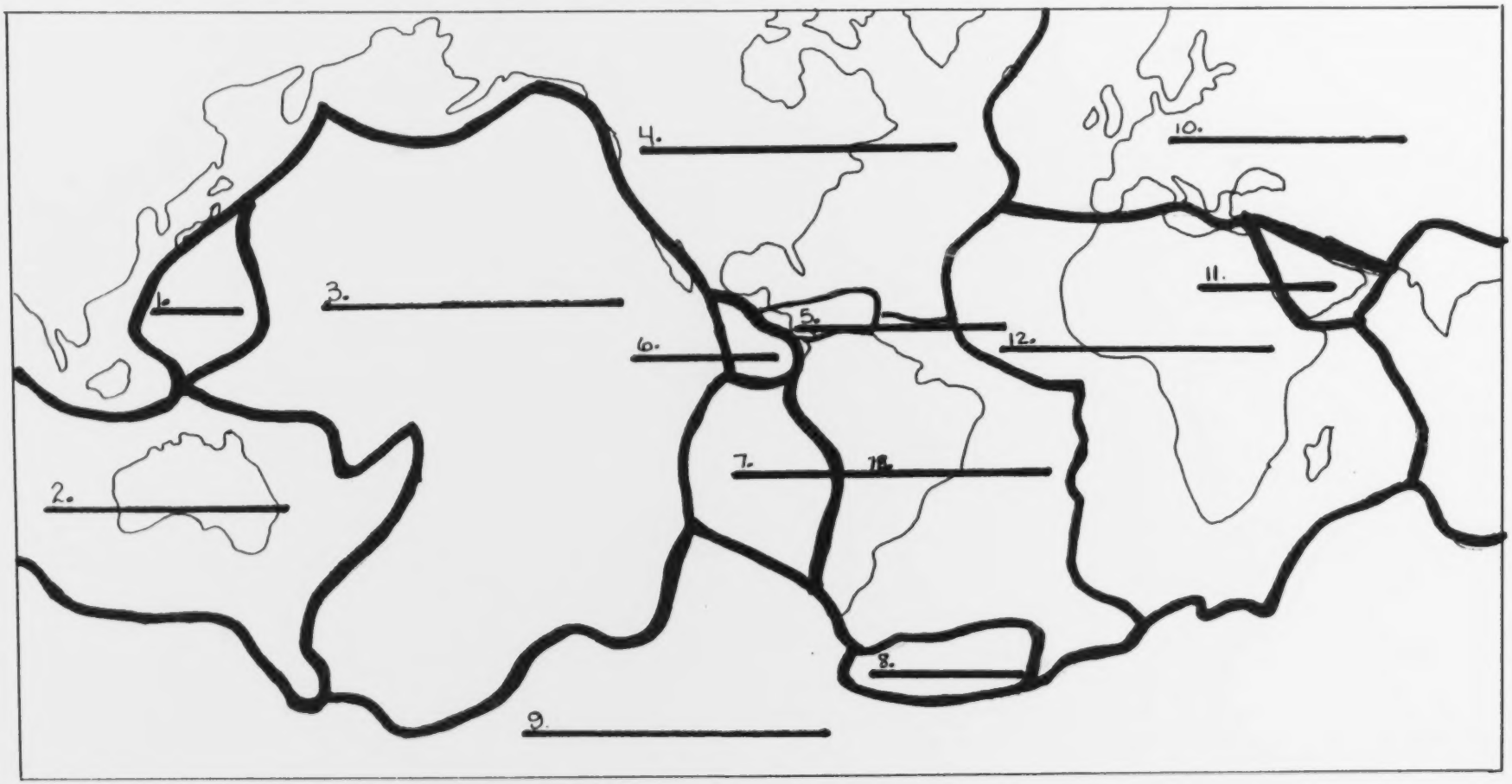
FIGURE 1.—Lithosphere plates of the world, showing boundaries that are presently active. Double line: zone of spreading, from which plates are moving apart. Line with barbs: zone of underthrusting (subduction), where one plate is sliding beneath another; barbs on overriding plate. Single line: strike-slip fault, along which plates are sliding past one another. Stippled area: part of a continent, exclusive of that along a plate boundary, which is undergoing active extensional, compressional, or strike-slip faulting. Compiled and adapted from many sources; much simplified in complex areas.

The Concepts

The Earth's crust is broken into moving plates of "lithosphere" (fig. 1). There are seven very large plates, each consisting of both oceanic and continental portions, and a dozen or more small plates (not all of which are shown in figure 1). Each plate is about 80 kilometers (50 miles) thick and can be pictured as having a shallow part that deforms by elastic bending or by brittle breaking, and a deeper part that yields plastically, beneath which is a viscous layer on which the entire plate slides. The plates tend to be internally rigid, and they interact mostly at their edges.

name _____

Name the plates, use your imagination! Your teacher will go over the names commonly used.



Look at a globe and look for features which might be associated with these boundaries. Label them on the map.

TEACHER SHEET
SIXTH GRADE - PLATE TECTONICS

Even through it has been established that the continents have moved through time, there are still many problems on how they moved. These diagrams illustrate the movements that could have happened during the last 510 million years. The evidence for this movement is difficult to understand, but real. In the elementary school level the reason why geologist feel that these diagrams are true,, cannot be explained. Just try and have fun with your students to understand the difference in the pattern. You can do several things with these diagrams:

(1) Have your students chart from one time frame to another the difference.

(2) See if some continents have been at the equator before. (yes, North America, 510 million years ago)

(3) Would the rocks reflect a different climate if that continent was in a different place? (yes)

(4) Have your students make a "flip movie" by placing them in the right order...we suggest you use a thicker paper.

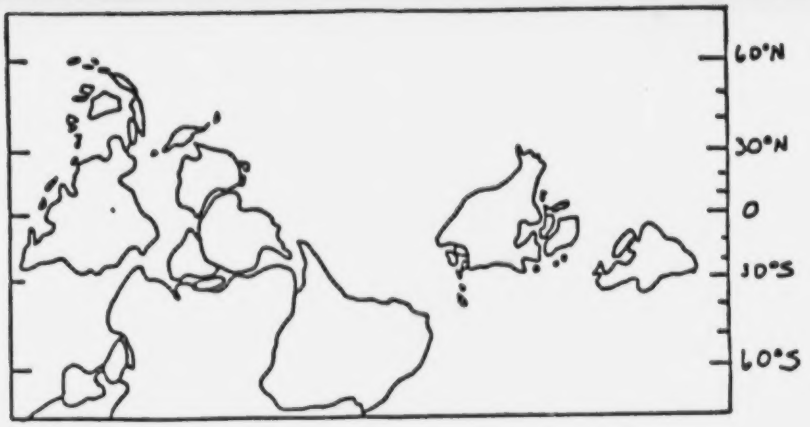
(5) If you have studied fossils in your class you might want to discuss if the fossils in rocks could tell you any clues about the continents past position. Yes, for example in Antarctic they have found trees...when could trees have been plentiful in Antarctic? 500-250 million years ago.

(6) Which continents have moved alot? North America, Austrialia

(7) Did we always have a Pacific Ocean and Atlantic Ocean? No

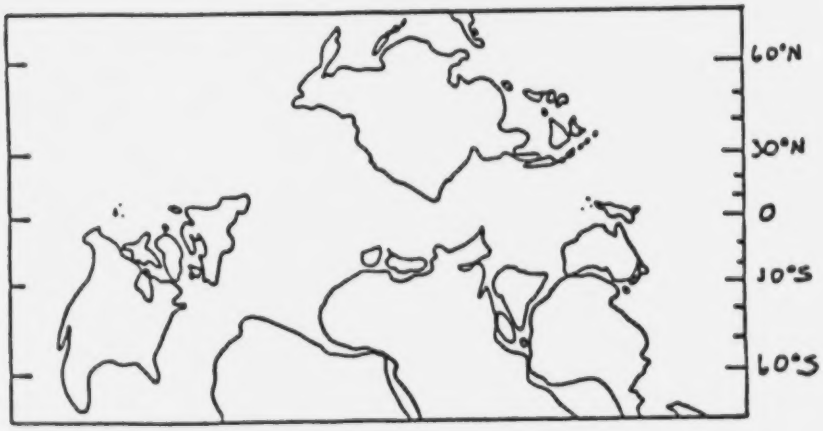
(8) Color one continent, one color, and trace it throughout the different diagrams. This makes it easy to identify.

(9) If you think your class is advanced, cover one of the diagrams on each sheet and see if your students can recreate what the missing diagram should look like.

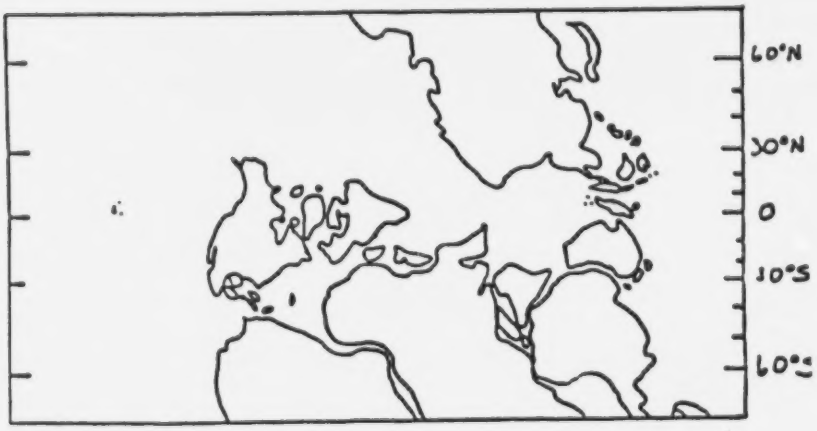


(oldest)

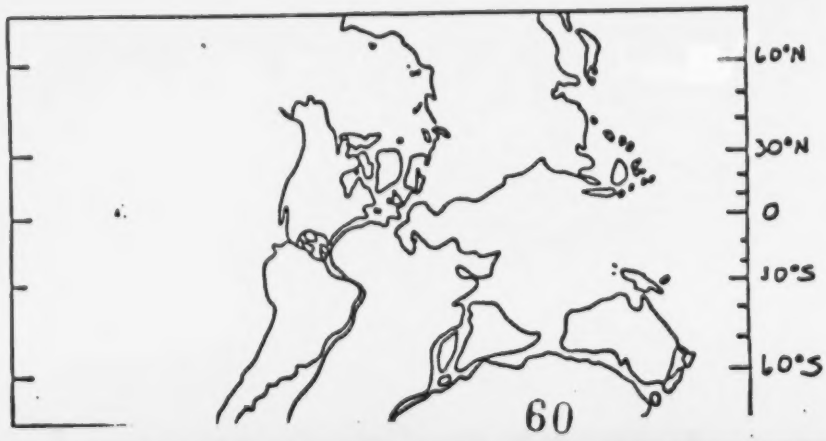
510
million years ago



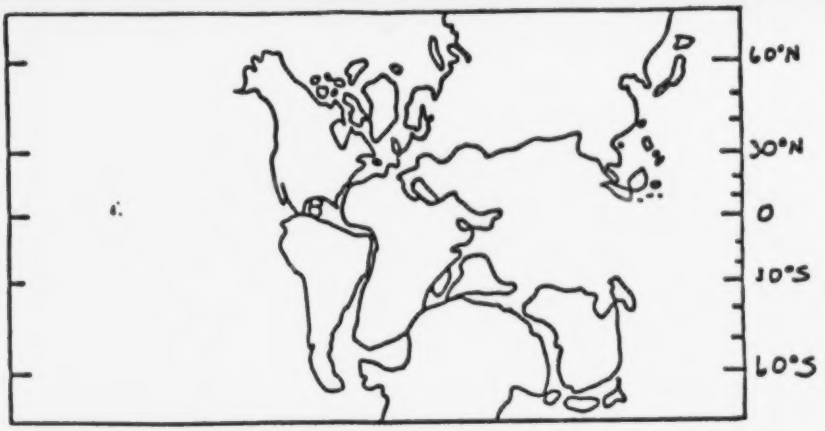
380
million years ago



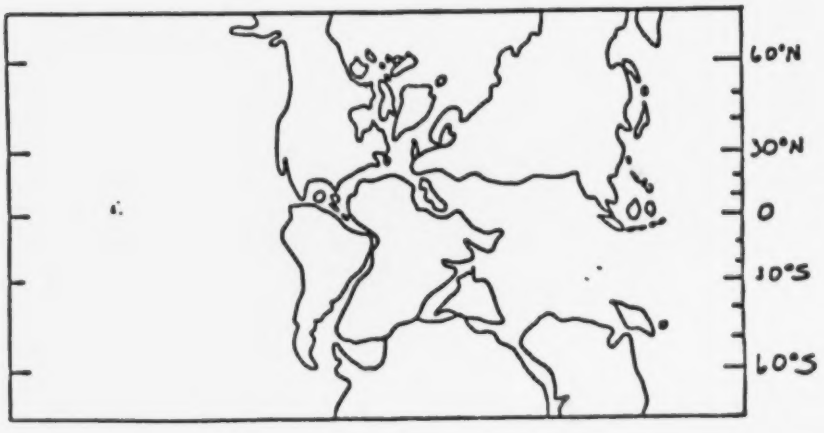
340
million years ago



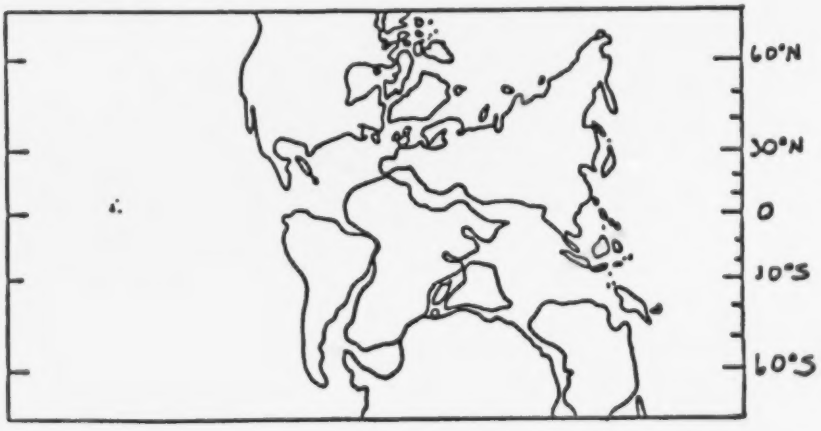
250
million years ago



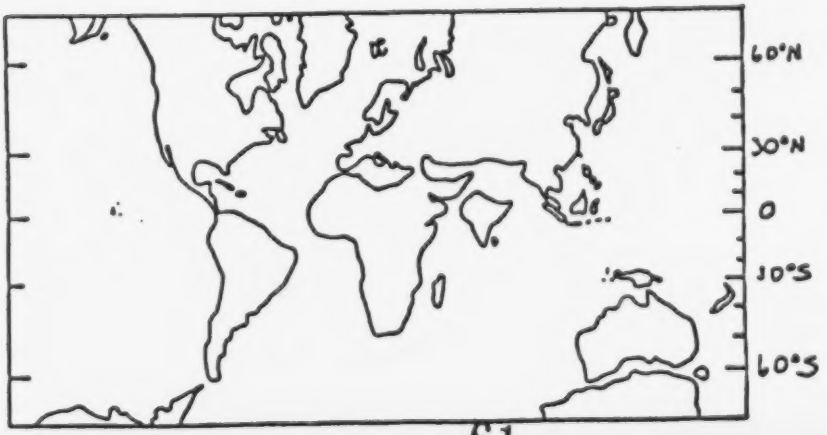
220
million years ago



170
million years ago



100
million years ago



50
million years ago

(youngest)

PLATE TECTONIC CYCLE

HAZARDS

Natural disasters have occurred throughout time. Catastrophes caused by volcanoes and earthquakes are not only spectacular but devastating. This unit describes what hazards can be produced by volcanoes and earthquakes, not only to humans but also to other structures that may be affected. Students should begin to learn that these hazards are natural. Humans must understand volcanoes and earthquakes and avoid danger as much as possible. But if you experience such an event, you should not be scared but prepared to act sensible and knowledgeablely. Students should also be acquainted with past damages to see that mother nature is a force that sometimes you cannot tame.

LOWER PRIMARY

A. EARTHQUAKE AND VOLCANO HAZARDS - What is a hazard? Can volcanoes and earthquakes destroy land and property? Can I tame an earthquake or a volcano? Will the earth open up and swallow me? Do I have to be scared?

B. WHERE DO I GO FOR HELP? - Who do I call? What happens if the lights go out? What happens if I get trapped? Should I cry? Where do I go?

C. HISTORICAL DAMAGE (VOLCANOES) - Mt. Vesuvius and Mt Etna (Italy), Mt Lassen and Mt Shasta (California), Mt St Helens (Washington), Krakatau (Indonesia), Paricutin (Mexico), Nevado del Ruiz (Columbia)

UPPER PRIMARY

D. HISTORICAL DAMAGE (EARTHQUAKES) - San Francisco, California (1906), Charleston, South Carolina (1886), Anchorage, Alaska (1964), Long Beach, California (1933)

E. HAZARDOUS AREAS - Are there areas in the world that have more volcanoes and earthquakes than others? Are some hazards not that dangerous? What are some warnings of an earthquake and volcano? Can you have earthquakes and volcanos together or can they occur separately?

F. HOW STRONG ARE EARTHQUAKES? - What does intensity mean? What is the difference between the Richter scale and the Mercalli scale? What is a seismograph? Are all earthquakes dangerous?

TEACHER SHEET
KINDERGARTEN - HAZARDS

This coloring and word exercise is to start a discussion with your children on the sounds of an earthquake. Discuss that there are natural sounds like "rumble", but there are also other sounds like "bang" and "crash" that indicate that something is getting broke. Ask the children which sounds they should avoid if an earthquake should occur. This exercise is trying to emphasis that the children should try an evaluate the situation after the earthquake and use all their senses to evaluate the severity of the earthquake.

name _____

Sounds of an earthquake.

BANG

CRASH

RUMBLE

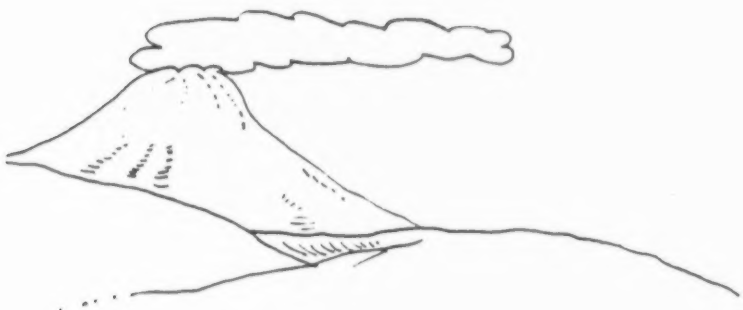
TEACHER SHEET
FIRST GRADE - HAZARDS

This coloring, drawing and handwriting exercise illustrates that a volcano does not have to kill anyone...especially when there aren't any people in the vicinity. Point out that there are different types of volcanoes, like Mt. St Helens and Nevado del Ruiz, in Columbia, that were explosive and killed people far away....but a volcano like Kilauea in Hawaii or Mt Etna, Italy would not be as harmful, because scientist know they will not violently explode.

name _____

Volcano Hazards

Draw : lava



gas

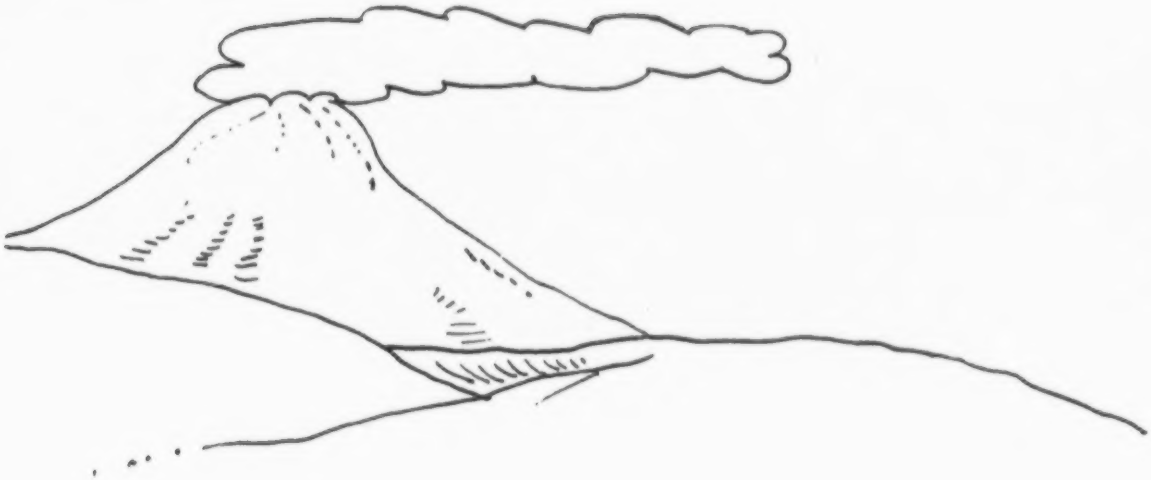
landslides

ash

name _____

Volcano Hazards

Draw : lava



gas

landslides

ash

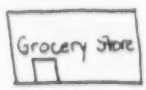
TEACHER SHEET
SECOND GRADE - HAZARDS

Students need to be informed where they should call or go after a severe earthquake. The answer to this exercise is different in your area than another. If a child lives in an urban area vs. a country area the types of services available would be different. Try to have the students assess why they would go to a certain area. Remember some phone lines would probably go down, prepare the students to see which area is the nearest to their home. Also, this exercise can be used in different situations...say a child is at home, at school, in church....where would they go from there.

name _____

Where do I go in case of a big earthquake?

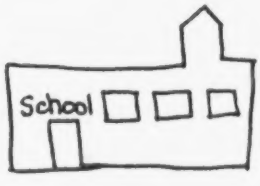
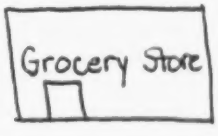
- color those places that you can either call or go to
- label which ones you can only go to - in case the phones are not working

call/walk to	walk to	no
 no	walk to	walk to
walk to	no	where else? _____

name _____

Where do I go in case of a big earthquake?

- color those places that you can either call or go to
- label which ones you can only go to – in case the phones are not working

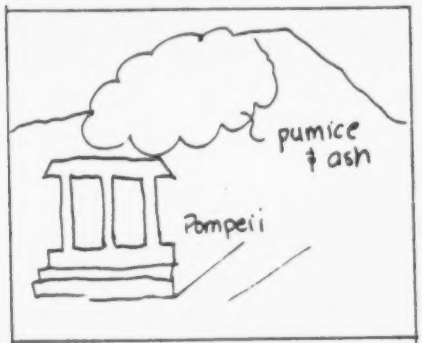
_____	 _____	_____
 _____	_____	_____
_____	_____	where else? _____

TEACHER SHEET
THIRD GRADE - HAZARDS

Volcanic activity has played a dominant role in shaping the surface of the earth. Not all volcanic activity is the same, some more harmful than other. Volcanoes like Mt. St Helens and Nevado del Ruiz (Columbia) are much more violent than the Mt. Etna (Italy) and Kilauea (Hawaii) volcanoes. This has to do with the generation of the magma at those particular site. This exercise looks at some historic volcanoes and has the students look at the different type of evidence that was left.

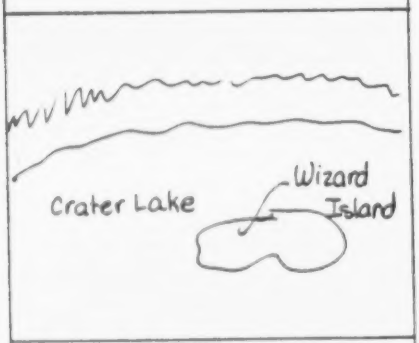
name _____

What evidence does a volcano leave to tell us?
Draw a picture of the eruption described.



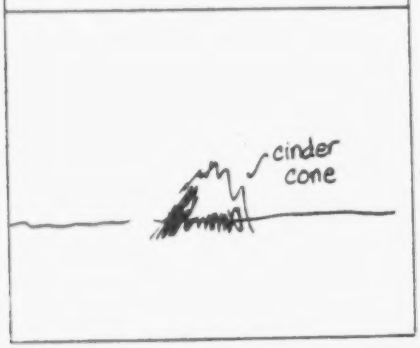
Pompeii, Mt. Vesuvius

In 79 A.D., Mt Vesuvius threw out an enormous volume of pumice and ash. This debri covered the city of Pompeii.



Crater Lake, Oregon

After a large eruption, the top of this volcano collapsed. The great hole was filled with water from rainfall and melting snow. A new eruption in the middle of the lake formed a cinder cone of Wizard Island.



Paricutín, Mexico

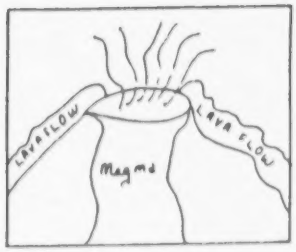
A cinder cone grew to a height of over 1500 ft. It first began in a cornfield in 1943 and covered an area with lava of more than 10 square miles.

BEST COPY AVAILABLE

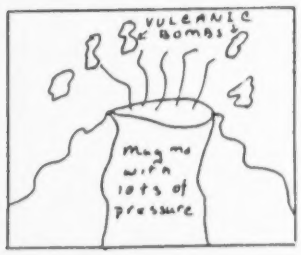
name _____

What evidence does a volcano leave to tell us?
Draw a picture of the eruption described.

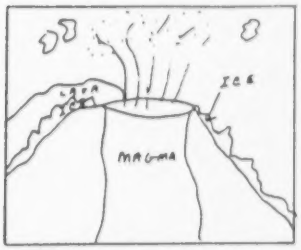
	Pompeii, Mt. Vesuvius In 79 A.D., Mt Vesuvius threw out an enormous volume of pumice and ash. This debri covered the city of Pompeii.
	Crater Lake, Oregon After a large eruption, the top of this volcano collapsed. The great hole was filled with water from rainfall and melting snow. A new eruption in the middle of the lake formed a cinder cone of Wizard Island.
	Paricutín, Mexico A cinder cone grew to a height of over 1500 ft. It first began in a cornfield in 1943 and covered an area with lava of more than 10 square miles.



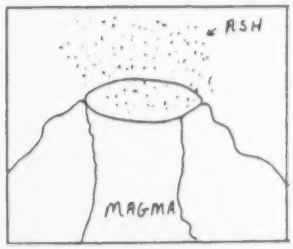
LAVA FLOW - hot liquid "rock" that will burn and destroy what is in its path.



VOLCANIC BOMBS - pieces of lava ejected from the volcano with such force that they can harm people.



MUD FLOWS - when a volcano is covered with ice and it erupts the temperature goes up enough to melt the ice which mixes with the ash and other material creating large mudslides.



ASH FALL - fine ash ejected from a volcano is dangerous when it is combined with poisonous gases.

When a volcano explodes it can create different types of hazards. Fill in the missing hazard.

1) An ash flow happens when very little pieces of the volcano fall on the ground.

2) Another type of hazard occurs when the "rock" flows down the side of the volcano. What is its name? lava flow

3) A third type of hazard occurs when pieces of lava are ejected from the volcano with great force and pressure. What is its name? volcanic bombs

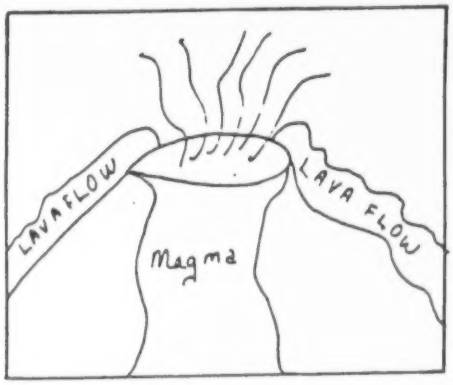
4) A fourth type of hazard that is created when melted ice and volcanic debris mix. What is its name? mud flow

BEST COPY AVAILABLE

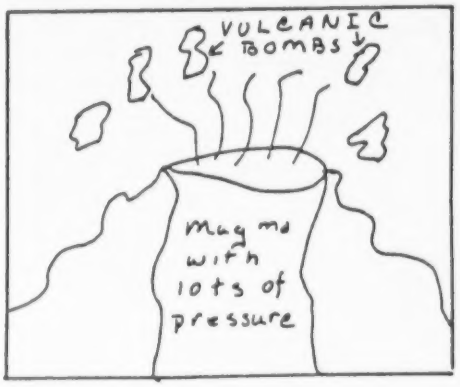
name _____

When a volcano explodes it can create many different kinds of hazards that can hurt people. In the following exercise, first color the picture and learn the name of the hazard. In the second part of the exercise fill in the missing volcanic hazard.

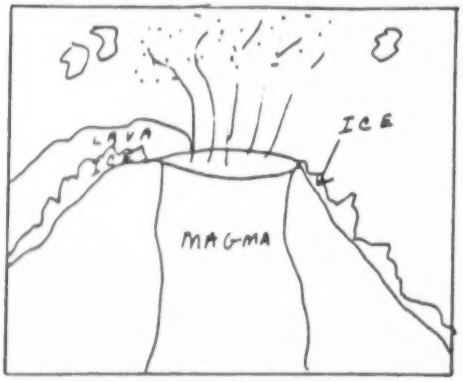
Part I



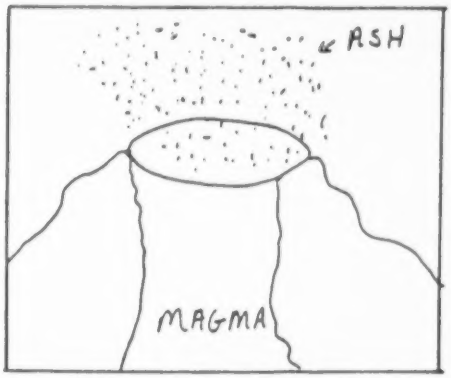
LAVA FLOW - hot liquid "rock" that will burn and destroy what is in its path.



VOLCANIC BOMBS - pieces of lava ejected from the volcano with such force that they can harm people.



MUD FLOWS - when a volcano is covered with ice and it erupts the temperature goes up enough to melt the ice which mixes with the ash and other material creating large mudslides.



ASH FALL - fine ash ejected from a volcano is dangerous when it is combined with poisonous gases.

Part II

When a volcano explodes it can create different types of hazards. Fill in the missing hazard.

1) An _____ happens when very little pieces of the volcano fall on the ground.

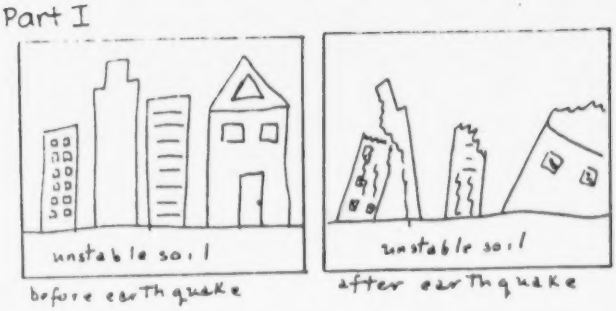
2) Another type of hazard occurs when the "rock" flows down the side of the volcano. What is its name? _____

3) A third type of hazard occurs when pieces of lava are ejected from the volcano with great force and pressure. What is its name? _____

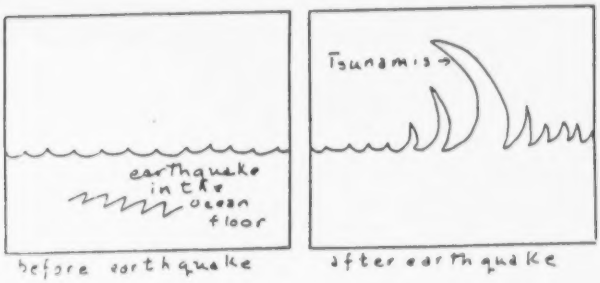
4) A fourth type of hazard that is created when melted ice and volcanic debris mix. What is its name? _____

BEST COPY AVAILABLE

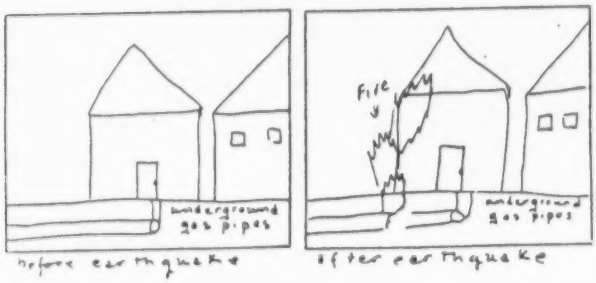
Part I



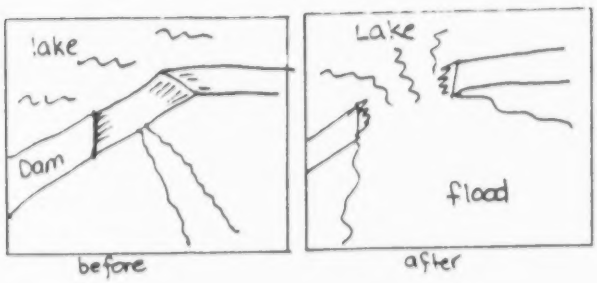
SOIL LIQUEFACTION - when a city is built on unstable soil it can shake like a bowl full of jello in an earthquake causing great damage.



TSUNAMIS - a giant wave set in motion by an earthquake in the ocean floor.



FIRE - fires occur when the ground moves so much that gas pipes are broken and the gas escapes.



FLOODS - a flood can occur if the earthquake is so strong it cracks a dam or levee holding back the water.

Part II

When an earthquake occurs it can create many hazards. Fill in the missing hazard.

1) A flood can happen if the earthquake causes damage to dams and levees in the affected area.

2) Liquefaction happens when cities are built on unstable soil.

3) When earthquakes happen on the sea floor a tsunamis can be created.

4) A fire can occur when earthquakes break gas pipes underground.

BEST COPY AVAILABLE

TEACHER SHEET
FOURTH GRADE - HAZARDS

This exercise looks at some situations that may happen during an earthquake. Using the enclosed chart of the Mercalli and Richter Scales, the students try and figure the intensity of the quake. The Richter scale measures the vibrations from earthquakes as they travel through the Earth, using a seismograph. The Mercalli scale measures the intensity of an earthquake using a series of certain key responses such as people awakening, movement of furniture, damage to chimney, etc. You can use this kind of presentation to have your students recall certain earthquakes that may have happened to them, and have them figure the intensity. Look at historic earthquakes like San Francisco (1906) and other earthquakes to figure their intensities.

NAME _____

Directions: Using the table on Mercalli and Richter Scales, figure the intensity (Mercalli) of the earthquake and then figure the magnitude of the earthquake (Richter).

1. Felt quite noticeable by persons indoors, especailly on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck.

Mercalli IV moderate Richter 4.3-4.8

2. Damage neglibile in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.

Mercalli X disastrous Richter 7-7.3

3. Not felt except by a very few under especially favorable conditions.

Mercalli II feeble Richter 3.5-4.2

4. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.

Mercalli VI, Very Strong Richter 5.5-6.1

5. Damage slight in specially designed structures; considerable damage in ordinary substantial building with partial collapse. Damage great in poorly built structues. Fall of chimney, factory stacks, columns, monuments, walls. Heavy furniture overturned.

Mercalli _____ Richter _____

Define Mercalli Intensity Scale: measures intensity compared to human terms

Define Richter Magnitude Scale: strength of an earthquake due to ground motion

NAME _____

Directions: Using the table on Mercalli and Richter Scales, fiqure the intensity (Mercalli) of the earthquake and then fiqure the magnitude of the earthquake (Richter).

1. Felt quite noticeable by persons indoors, especailly on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck.

Mercalli _____ Richter _____

2. Damage neglibile in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.

Mercalli _____ Richter _____

3. Not felt except by a very few under especially favorable conditions.

Mercalli _____ Richter _____

4. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.

Mercalli _____ Richter _____

5. Damage slight in specially designed structures; considerable damage in ordinary substantial building with partial collapse. Damage great in poorly built structues. Fall of chimney, factory stacks, columns, monuments, walls. Heavy furniture overturned.

Mercalli _____ Richter _____

Define Mercalli Intensity Scale: _____

_____

_____

Define Richter Magnitude Scale: _____

_____

Scale of Earthquake Intensities with Approximately Corresponding Magnitudes

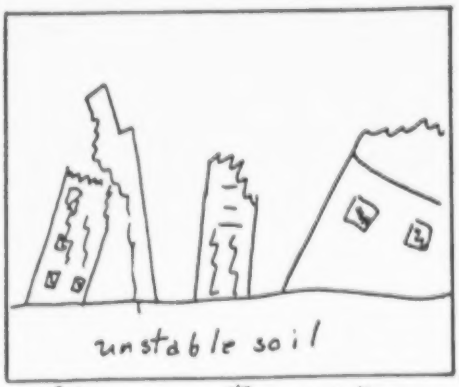
Intensity	*Description of characteristic effects*	*Magnitude corresponding to highest intensity reached*
I	*Instrumental:* detected only by seismographs	
II	*Feeble:* noticed only by sensitive people	3·5
III	*Slight:* like the vibrations due to a passing lorry; felt by people at rest, especially on upper floors	to 4·2
IV	*Moderate:* felt by people while walking; rocking of loose objects, including standing vehicles	4·3
V	*Rather Strong:* felt generally; most sleepers are awakened and bells ring	to 4·8
VI	*Strong:* trees sway and all suspended objects swing; damage by overturning and falling of loose objects	4·9–5·4
VI	*Very Strong:* general alarm; walls crack; plaster falls	5·5–6·1
VIII	*Destructive:* car drivers seriously disturbed; masonry fissured; chimneys fall; poorly constructed buildings damaged	6·2
IX	*Ruinous:* some houses collapse where ground begins to crack, and pipes break open	to 6·9
X	*Disastrous:* ground cracks badly; many buildings destroyed and railway lines bent; landslides on steep slopes	7–7·3
XI	*Very Disastrous:* few buildings remain standing; bridges destroyed; all services (railways, pipes and cables) out of action; great landslides and floods	7·4–8·1
XII	*Catastrophic:* total destruction; objects thrown into air; ground rises and falls in waves	>8·1 (maximum known, 8·9)

name _____

Part I

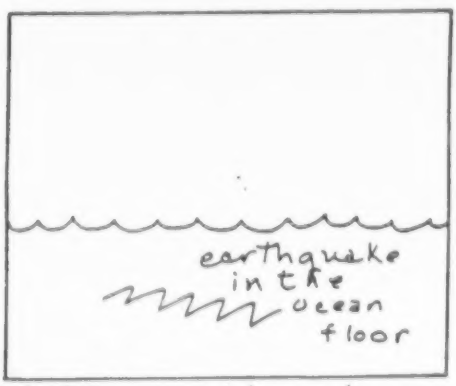
When an earthquake occurs it can create different kinds of hazards that affect people. First color the picture and learn the name of the hazard. Second fill in the missing earthquake hazard.

before earthquake

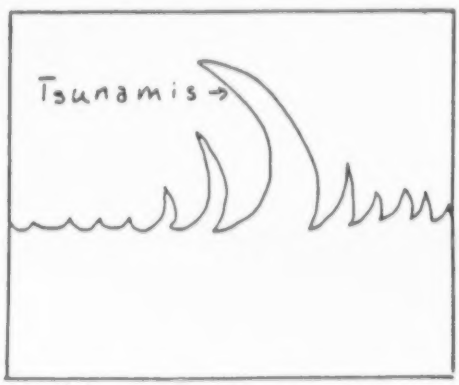


after earthquake

SOIL LIQUEFACTION - when a city is built on unstable soil it can shake like a bowl full of jello in an earthquake causing great damage.

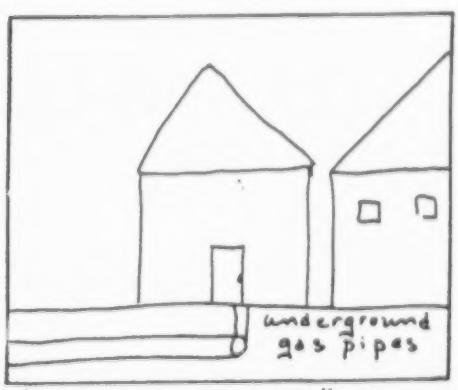


before earthquake

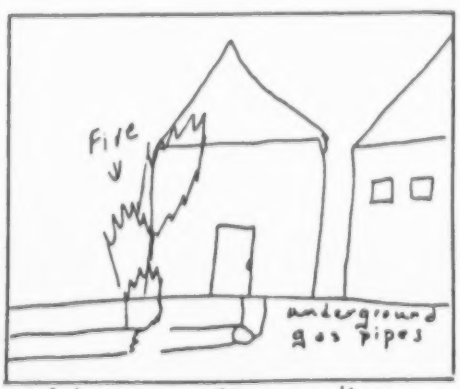


after earthquake

TSUNAMIS - a giant wave set in motion by an earthquake in the ocean floor.

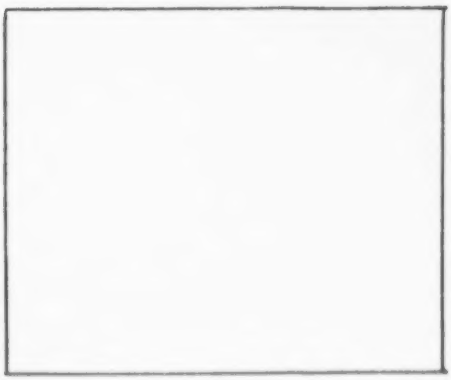


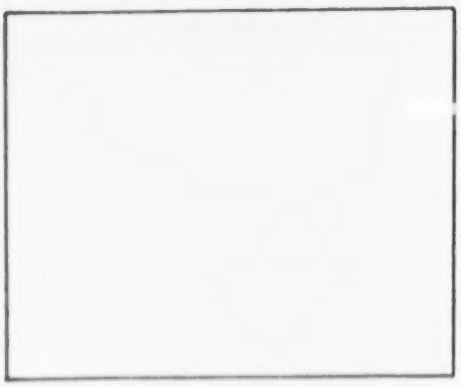
before earthquake



after earthquake

FIRE - fires occur when the ground moves so much that gas pipes are broken and the gas escapes.





FLOODS - a flood can occúr if the earthquake is so strong it cracks a dam or levee holding back the water.

Part II

When an earthquake occurs it can create many hazards. Fill in the missing hazard.

1) A _____ can happen if the earthquake causes damage to dams and levees in the affected area.

2) _____ happens when cities are built on unstable soil.

3) When earthquakes happen on the sea floor a _____ can be created.

4) A _____ can occur when earthquakes break gas pipes underground.

TEACHER SHEET
FIFTH GRADE - HAZARDS

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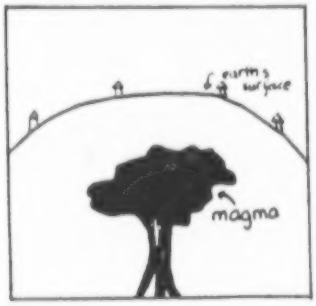
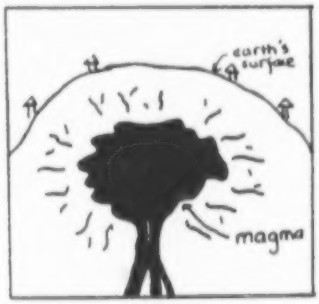
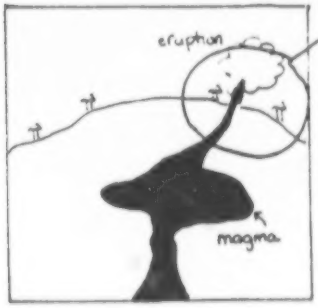
Not all areas in the world are a volcano or earthquake hazardous area. These two exercises show: (1) not all areas are affected by an eruption and (2) there are areas in the world that are more prone to earthquakes.





How can scientists predict that this volcano may erupt?

- earthquakes
- earth may rise (kind of like a pimple on the face).



Color those homes in red that are affected by the eruption of this volcano.

What else might be affected by this eruption?

atmosphere (ash).

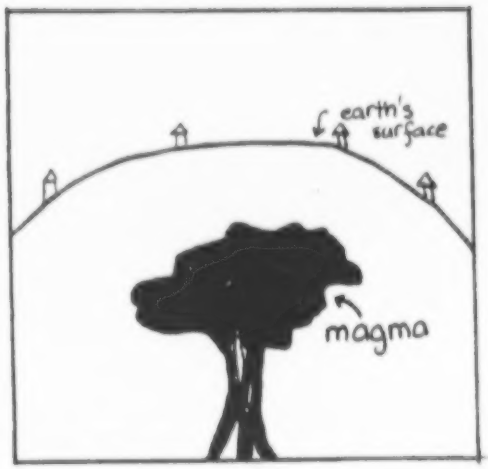
If past earthquakes give us a clue to future earthquakes ... List the areas that you would most likely feel earthquakes.

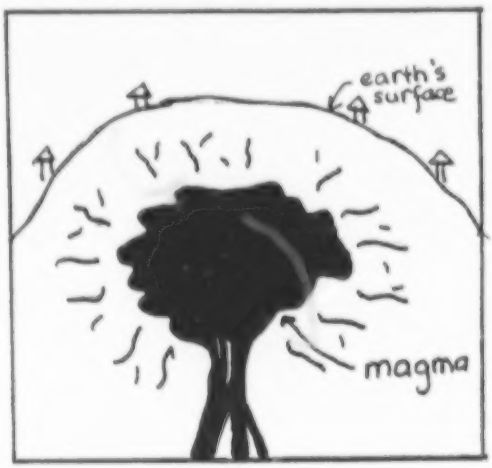
along the rim of the Pacific
India, Parts of China

List the areas that you would not feel big earthquakes.

eastern part of North & South America
Africa
north Siberia

name _____



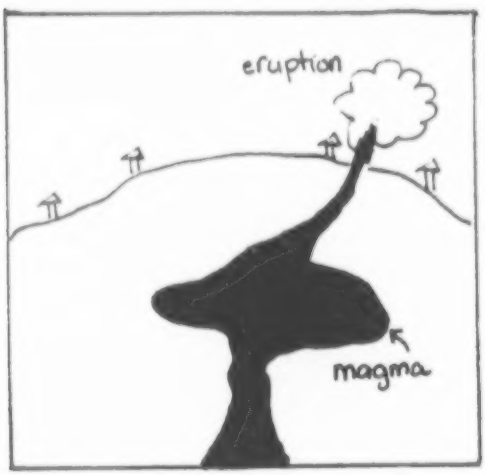


How can scientists predict that this volcano may erupt?

_____

_____

_____



Color those homes in red that are affected by the eruption of this volcano.

What else might be affected by this eruption?

_____

_____

_____

_____

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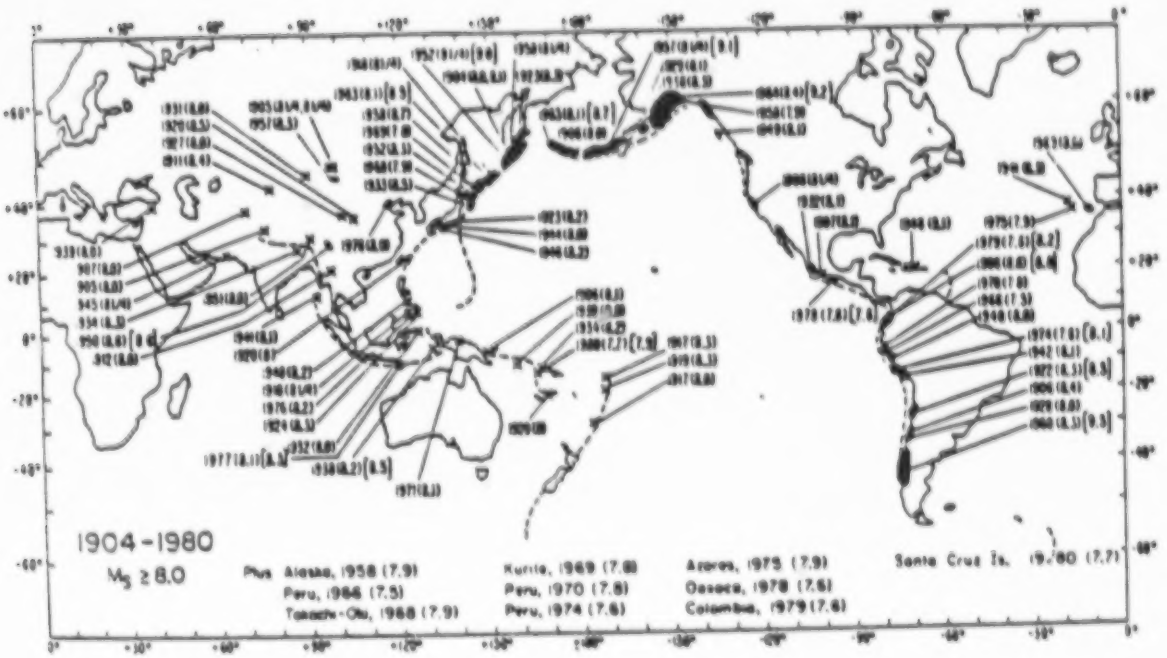
name _____ _____



Great and large earthquakes for the period from 1904 to 1980. The surface-wave magnitude M_s is given in the brackets for some earthquakes, including the ten largest earthquakes. Major rupture zones are indicated by dark zones. (Richter Scale)

If past earthquakes give us a clue to future earthquakes ... List the areas that you would most likely feel earthquakes.

_____

_____

_____

_____

List the areas that you would not feel big earthquakes.

_____

_____

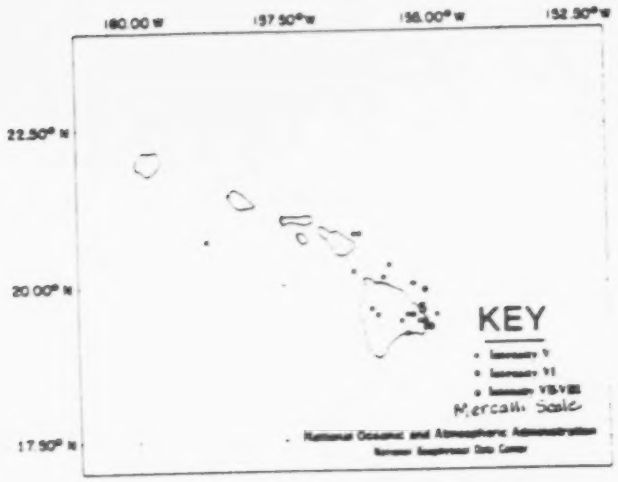
_____

_____

BEST COPY AVAILABLE

name _____

Look at the maps of Alaska and Hawaii. They show how strong the earthquakes were between 1971-1980. The higher the intensity the stronger the earthquake.



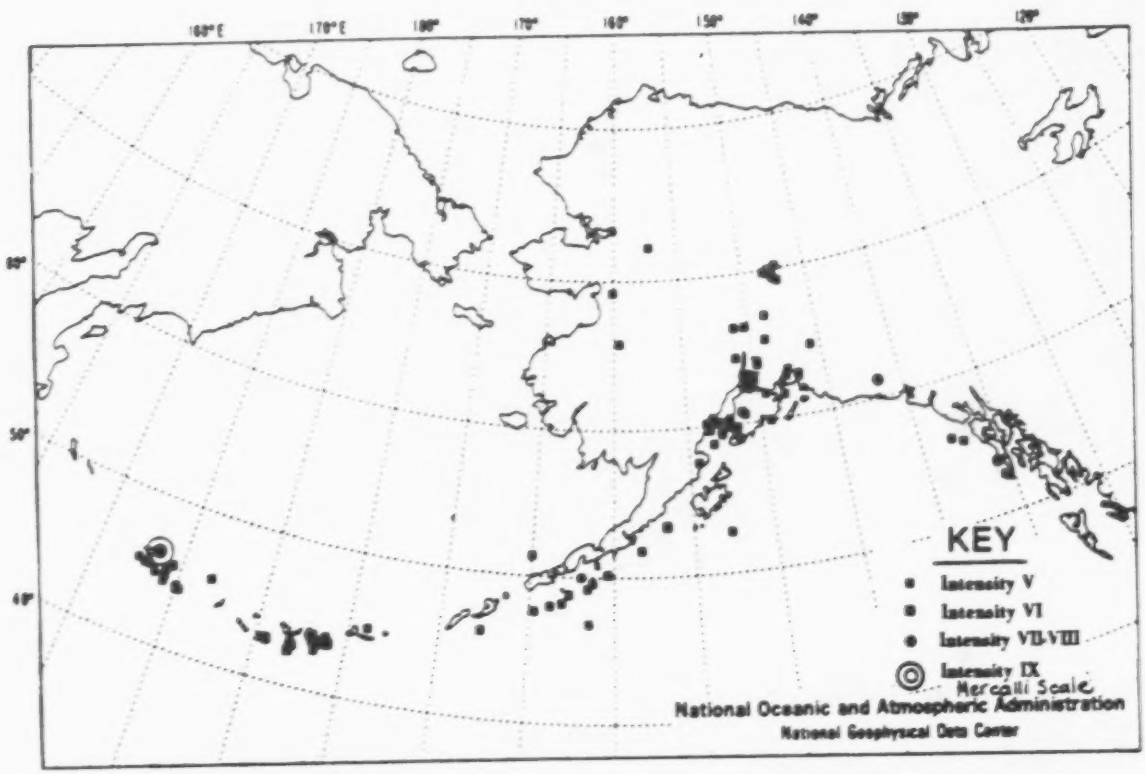
Earthquake intensities in Hawaii, 1971-80.

Which state had the most earthquakes?

Which state had the strongest earthquakes?

Color in red those areas you think would be the most hazardous to live. Why?

_____



Earthquake intensities in Alaska, 1971-80.

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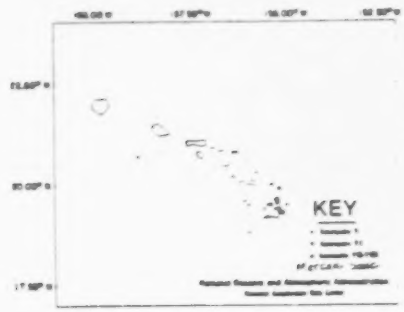
TEACHER SHEET
SIXTH GRADE - HAZARDS

This exercise uses the Mercalli Intensity Scale to see if Alaska or Hawaii has stronger earthquakes. Hawaii doesn't have as strong earthquakes and Alaska, because Alaska is along a converging plate, whereas Hawaii is not.

Name _____

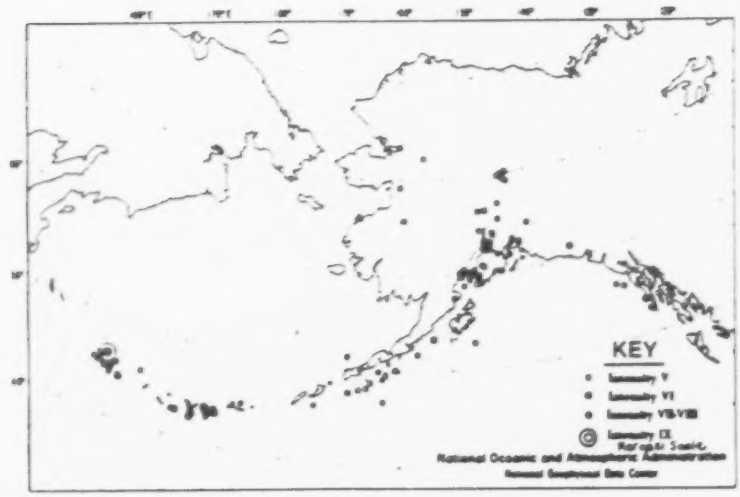
Look at the maps of Alaska and Hawaii. They show how strong the earthquakes were between 1971-1980. The higher the intensity the stronger the earthquake.



Earthquake intensities in Hawaii, 1971-80

Which state had the most earthquakes? Alaska
Which state had the strongest earthquakes? Alaska

Color in red those areas you think would be the most hazardous to live. Why?
the plates are converging in Alaska, not in Hawaii



Earthquake intensities in Alaska, 1971-80